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THE GOVERNMENT OF THE PHILIPPINE ISLANDS
DEPARTMENT OF AGRICULTURE AND NATURAL RESOURCES
BUREAU OF AGRICULTURE

ADRIANO HERNANDEZ, *Director*

BULLETIN No. 18

THE MANGO

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P. J. WESTER
Agricultural Advisor

SECOND REVISED EDITION

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FOREWORD

The first edition of this bulletin, issued in 1911, has been out of print for several years, and to meet an increasing demand for information about the mango it appears desirable to republish it. The new edition has been revised in the light of additional data accumulated in the past nine years but the aim being primarily to convey practical information, the discussion of the nomenclature, geographical distribution, and the history of the mango contained in the first issue have not been retained here. Most bibliographical references have also been left out. A brief discussion of the species of *Mangifera* with edible fruits other than the mango has seemed pertinent, as two species are already of considerable importance in the dietary of the people in some parts of the Philippines; and at least one, the Bauno, is certain to become a fairly important fruit when better known and when good grafted varieties shall have been developed.

In its compilation the descriptive list of the Indian mangos swelled to such large proportions that it has seemed best to publish it separately.

The author wishes to acknowledge his indebtedness to Mr. Wilson Popenoe for the information about the mango situation in Florida; to Prof. J. E. Higgins, College of Agriculture, Los Baños, for the data about Hawaii; and to Dr. Mario Calvino, Director, *Estación Experimental Agronómica*, Santiago de las Vegas, Cuba, for the information about the mango in that Island. Dr. David Fairchild, Agricultural Explorer in charge of the Office of Foreign Seed and Plant Introduction, Bureau of Plant Industry, United States Department of Agriculture, kindly furnished the photographs of the Amini, Cambodiana, and Sandersha mangos. The drawing of figure 7 was presented by Mr. Gonzalo Merino, Chief, Pest Control Division of this Bureau.

P. J. WESTER.

MANILA, P. I., September 25, 1920

CONTENTS

	Page.
Introduction	9
Botany	11
Species of <i>Mangifera</i> other than the mango.....	12
The embryony of the mango.....	17
The classification of the mango.....	18
The mango in the Philippines.....	19
Introduction	19
Seedling types	23
Descriptions of the Philippine mangos.....	24
The mango in Florida, Hawaii, Porto Rico and Cuba.....	28
Grafted varieties in India.....	30
The mango as an ornamental tree.....	31
Climate	31
Soil	32
Propagation	33
Preliminary remarks	33
The rearing of stock plants.....	33
Graftage	36
Shield budding	39
Crown grafting	41
Cleft grafting.....	43
Inarching	43
Topworking old trees.....	46
Shipment of material for propagation.....	47
Clearing and planting.....	48
Tillage, cover, and secondary crops.....	50
Pruning	51
Fertilization	52
Forcing	53
Harvesting and marketing.....	54
Composition and uses of the mango.....	55
Jelly	56
Marmalade	56
Preserves	56
Candied mangos.....	56
Chutney	57
Other uses of the mango.....	57
Diseases	57
Insect pests	59
Preliminary remarks	59
The mango hopper.....	60
Fruit flies	60
Mango weevils	63
Scales and sucking insects.....	64
Miscellaneous insect pests.....	65

	Page.
Spraying	67
Formulas for fungicides and insecticides.....	68
1. Bordeaux mixture	68
2. Good's caustic potash whale-oil soap.....	68
3. Kerosene emulsion	68
4. Resin wash	69
5. Self-boiled lime-sulphur wash.....	69
6. Paris green.....	69
7. Arsenate of lead.....	70
8. The Mally fruit fly remedy.....	70

ILLUSTRATIONS

PLATES

PLATE I. Mango tree in the Philippines: Pahutan seedling.....*Frontispiece.*

Facing page—

II. (a) Mango flowers	12
(b) A germinating seed of the Carabao mango illustrating polyembryony	12
III. Carabao mango tree, illustrating its usefulness as a shade tree	16
IV. (a) Bauno, <i>Mangifera caesia</i> , on Basilan.....	20
Huani, <i>Mangifera odorata</i> , Zamboanga.....	20
V. Carabao mangos, illustrating variation in the fruit.....	24
VI. Pico mangos, illustrating variation in the fruit.....	28
VII. (a) The Carabao mango, fruit and seed.....	32
(b) The Pico mango, fruit and seed.....	32
VIII. (a) The Binoboy mango, fruit and seed.....	36
(b) The Señora mango, fruit and seed.....	36
IX. (a) The Pahutan mango, fruit and seed.....	40
(b) The Bauno, <i>Mangifera caesia</i> , longitudinal section and seed	40
X. (a) The Amini mango.....	44
(b) The Cambodiana mango.....	44
XI. The Sandersha mango.....	50
XII. (a) Inarching	52
(b) Inarched plant ready for the field.....	52
XIII. Shield budded and cleft grafted mangos. Singalong Experiment Station.....	54
XIV. (a) A 3-years old mango seedling about 4 months after the top was cut back to induce the production of young growth suitable for shield budding.....	56
(b) A top worked (shield budded) young mango tree eight weeks after insertion of the buds.....	56
XV. (a) Huani, <i>Mangifera odorata</i> , shield budded on the mango	60
(b) A young topworked mango tree (Sandersha) in Miami, Florida	60
XVI. A newly planted orchard with velvet beans as cover crop, Lamao Experiment Station	62
XVII. (a) "Fire place" and smoke stack used in forcing mango trees into fruiting, Cavite.....	64
(b) Near view of the fire place.....	64

TEXT FIGURES

	Page.
Fig. 1. Shield budding of the mango in progressive stages: (a) Scion, (b) section of stock prepared for insertion of the bud, (c) bud inserted, (d) bud tied, (e) shield bud, (f) budding knife Facing—	32
2. The proper way of cutting a shield bud.....	39
3. A roll of grafting tape.....	41
4. Crown grafting of the mango: (a) Scion inserted in stock as seen from the front, (b) scion inserted in stock as seen from the side, (c) scion ready for insertion, (d) scion inserted, tied and waxed, (e) water proof paper bag covering scion to prevent evaporation.....	42
5. Cleft grafting of the mango in progressive stages: (a) Scion prepared for insertion, (b) stock plant prepared for insertion, (c) scion inserted in the stock, (d) scion inserted and tied, (e) paper cylinder containing moist moss around the scion	45
6. Planting board.....	49
7. Pruning tools: (a) Knife, (b) shears, (c) saw, and (d) tree pruner.....	52
8. A mango fruit fly, <i>Chaetodacus ferrugineus pedestris</i> Bezzi....	61
9. Barrel sprayer.....	67

THE MANGO

INTRODUCTION

The mango is undoubtedly the most popular dessert fruit in the Philippines—and deservedly so. The mangosteen has a more delicate flavor, but it lacks the luscious tang and aroma of the mango; it is more difficult of cultivation than the mango, is of slow growth and has a short season; hence it has never attained the popularity of the mango, which grows everywhere in the Islands with the freedom and luxuriance of a forest tree, attaining, under favorable conditions, dimensions that few of these surpass. The superiority in flavor of the best Philippine mangos over those grown in other countries is generally well recognized.

The mango is also considered to be one of the choicest of the fruits in India, where the tree has been cultivated since time immemorial, and where numerous varieties have been cultivated for centuries.

The propagation and dissemination of the mango in both hemispheres, except in India, have been effected almost exclusively by means of seeds until within the last two decades. The many successful importations of grafted plants from India into the United States have greatly stimulated the interest in the cultivation of the mango in southern Florida, Porto Rico, Hawaii and Cuba, with the result that after many attempts various more or less successful methods of vegetative propagation have been worked out, and more budded trees are now being planted in these countries than anywhere else, though still by no means on the scale that was anticipated fifteen or even ten years ago.

In the United States this has been attributed to the fact that the mango season coincides with that of the peach, and while this is no doubt a contributing factor the disappointing qualities of many of the much heralded East Indian grafted mangos imported into the United States probably to an even greater degree cooled the ardor of the erstwhile mango enthusiasts. Then, the shield budding method described in the former edition of this Bulletin, while simple enough, and far in advance of other

methods of vegetative propagation of the species then practiced, was still too complicated for general acceptance, and the effect of later improvements in the art have not yet had time to make themselves felt in the field. In Hawaii the introduction of the Mediterranean fruit fly, *Ceratitis capitata* Wied., has been an additional deterrent.

In the Philippines the mango season begins so early in the year that fruit exported to Hongkong, China and Japan would meet with very little competition from temperate fruits. Again, when the superior quality of the Philippine mango is considered it would appear that a well organized attempt to introduce the mango in the fruit trade in the countries mentioned has a good prospect of success. Nor is this the only prospective market for the Philippine mango. Some years ago the author in passing through Singapore was told by residents who had eaten them that the Philippine mango would outsell all others in Singapore without difficulty. This assertion it was not difficult to believe after having sampled the mangos marketed in Singapore, which were fibrous and of poor quality generally. The mango in Java is likewise greatly inferior to the Philippine mango and the populous big cities of that Island could unquestionably absorb considerable quantities of this fruit. Furthermore, the preservation of mangos opens up another avenue for their disposal hitherto untouched. Preserved mangos are of excellent quality, and possibly mangos could be evaporated and canned as prunes are in California and France.

The mango has a multitude of different names in the Asiatic tropics where it has been long in cultivation. Of these the Malay name *mangga* has, in its corrupted form *mango*, been adopted as the vernacular name in English.

In India and Ceylon, probably the ancestral home of the mango, the tree is held sacred by the Hindus and is inextricably connected with their mythology and folklore. In India it is grown up to 30° N. latitude, and is believed to have been under cultivation for a period of 4,000 years.

The mango is not mentioned in accounts of European travelers until in the fourteenth century, but as travel increased with the improved facilities therefor, the mango was gradually introduced from India into other countries until now it is found in all parts of the tropics. In most countries where it has been introduced the mango has become naturalized. In Florida it is grown up to 27° N. latitude, considerably north of the frostline.

BOTANY

The family *Anacardiaceae*, in which the genus *Mangifera* belongs, is comparatively poor in economics though it contains a few other genera including several more or less useful plants. One of the most valuable is probably the quebracho, *Loxopterygium lorentzi*, as a source of timber and tannin extracts. Among related fruit trees the pistach, *Pistacia vera* L., is the most important but does not thrive in the tropics. Tropical species that are of more or less importance because of their fruits include the Hevi, *Spondias cytherea* Sonn., the Ciruela, *S. purpurea* L., the Mombin, *S. lutea* L. and the Imbu, *S. tuberosa* Arr., all of which have been introduced into the Philippines. The Lanno, *S. pinnata* Kurz., is native to the Philippine Archipelago. The Cashew, *Anacardium occidentale* L., Gandaria, *Bouea macrophylla* Griff., and Rumeniya, *B. burmanica* Griff., of which the two first named species have been introduced into the Philippines, are also related to the mango. The Dao, *Dracontomelum dao* M. & R.; Lamio, *D. edule* Skeels; Kamiring, *Semecarpus cuneiformis* Bco.; and Manalu, *S. gigantifolia* F. Vill., are four species native to the Philippines the fruits of which are edible but of little value. The Dao is a good timber tree.

The genus *Mangifera* (from "mango," the Hindoo name for the fruit and "fero," to bear) to which the mango belongs, contains, according to Engler and Prantl, twenty-seven species. The Index Kewensis enumerates forty-six species, all except two (*M. africana* Oliv. a native of West Africa, and *M. laxiflora*, of the Island of Mauritius) being indigenous to India and Malaysia.

The mango, *Mangifera indica* L. (Plate I), is an evergreen tree that in cultivation varies in height from a tall shrub to a tree 15 to 20 meters high, with a trunk that sometimes is 1.5 meters or more in diameter. Very large trees exist in India. Woodrow¹ mentions a mango tree that measured "seventeen feet in circumference four feet from the ground." The leaves are alternate, stalked, linear-lanceolate, entire, leathery, 13 to 30 centimeters long, which bruised when they are young exhale an aromatic odor which varies considerably in the different types and varieties. The small, reddish-white, yellowish or greenish, polygamous, pungently odorous and melliferous flowers are borne on pubescent terminal panicles from 15 to 40 centimeters long. The small racemes that make up the terminal panicle are in some instances subtended by small leaves. As

¹ Woodrow, G. M., The Mango, 1904, p. 7.

many as 4,200 flowers have been counted on one panicle. Comparatively few flowers are perfect, the staminate strongly preponderating. The color, size and odor of the flowers, the size of the panicle, and the proportion of perfect to staminate flowers, vary in the different races and varieties. The sepals are five, oblong, concave; the five lanceolate petals are inserted at the base of a tumid disk; the fertile stamens are one with four staminodia; the ovary is one-celled, the style filiform. The pollen is scant. The pollination is effected largely by the wind, and in part by insects. The fruit is obliquely reniform, and exceedingly variable in form and size, from not larger than a small plum up to fruits having a weight of over 2,700 grams, and also differing widely as to the prevalence of fiber in the meat. The skin is green, yellowish, or red in many shades according to the race or variety, and is usually dotted with numerous lenticels. The stigmatic area may be even, or form a more or less prominent "nak,"² located near the beak, or well above it on the lower ventral side. The seed is reniform, and usually contains from one to six embryos.

SPECIES OF MANGIFERA OTHER THAN THE MANGO

In addition to the mango the genus *Mangifera* includes the following species, according to the Index Kewensis, though it is probable that a considerable number of them are synonymous:

Mangifera africana Oliv. TROPICAL AFRICA.

—*altissima* Blco. PHILIPPINES, SUNDA ISLANDS.

—*andamanica* King. ANDAMAN ISLANDS.

—*caesia* Jack. MALAYA.

—*caloneura* Kurz. BURMA.

—*camptosperma* Pierre. COCHIN CHINA.

—*cochinchinensis* Engl. COCHIN CHINA.

—*duperreana* Pierre. COCHIN CHINA.

—*foetida* Lour. MALAYA.

—*fordiana* Oliv. HONGKONG.

—*gedebi* Miq. SUMATRA.

—*glauca* B. JAVA.

—*gracillipes* Hook. f. MALACCA.

—*griffithi* Hook. f. MALACCA.

—*khasiana* Pierre. HIMALAYA REGION.

—*lagenifera* Griff. MALAYA, SUNDA ISLANDS.

—*langang* Miq. SUMATRA.

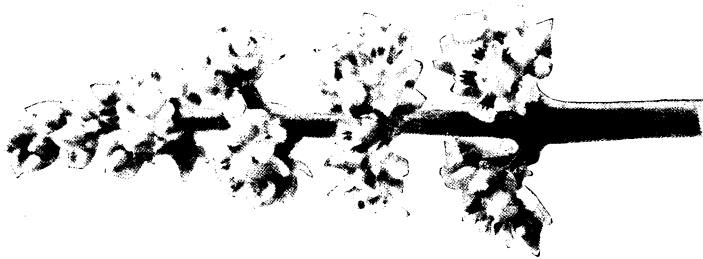
—*laurina* Bl. MALAYA.

—*laxiflora* Desr. MAURITIUS.

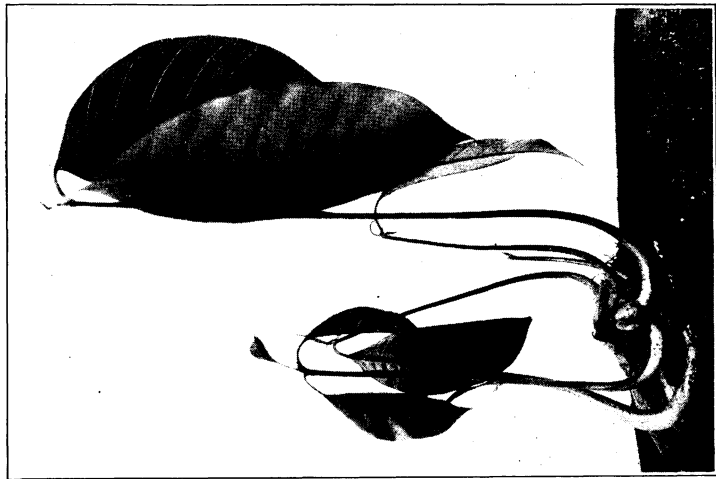
—*longipes* Griff. MALAYA, PHILIPPINES.

—*longipetiolata* King. MALACCA.

² Nak is the native Hindoo word for the pistillate area of the fruit. Jour. Royal Hort. Soc., 1901-2, Vol. XXVI, p. 756.



(a) Mango flowers (twice enlarged)



(b) A germinating seed of the Carabao mango illustrating polyembryony

- macrocarpa* Bl. JAVA.
- maingayi* Hook. f. MALACCA.
- membranacea* Bl. MOLUCCAS.
- microphylla* Griff. MALACCA.
- minor* Bl. MOLUCCAS.
- monandra* Merr. PHILIPPINES.
- mucronulata* Bl. NEW GUINEA.
- oblongifolia* Hook. f. MALACCA.
- odorata* Griff. MALAYA.
- paroifolia* Boerl. SUMATRA.
- polycarpa* Griff. MALACCA.
- quadrifida* Jack. MALAYA.
- pentandra* Hook. f. MALACCA.
- reba* Pierre. COCHIN CHINA.
- rigida* Bl. SUMATRA.
- scortechini* King. INDIA.
- sclerophylla* Hook. f. MALACCA.
- spathulaefolia* Bl. BORNEO.
- similis* Bl. MALAYA.
- superba* Hook. f. MALACCA.
- sylvatica* Roxb. HIMALAYA REGION.
- taipon* Ham. ex. Miq. NEW GUINEA.
- timorensis* Bl. TIMOR.
- zeylanica* Hook. f. CEYLON

The following species are known to bear edible fruits:

- Mangifera caesia* Jack. BAUNO
- odorata* Griff. HUANI
- foetida* Lour. BACHANG
- altissima* Blco. PAHO
- sylvatica* Roxb. KOSHAM
- lagenifera* Griff. LANDJOET
- langang* Miq. LANGOENG
- similis* Bl. ASAM KOEMBANG

The more important of these species are the three first named. Though edible, the fruit of the others are of very little value.

The BAUNO, *Mangifera caesia* Jack (Bayuno, Baluno, Malono) (Plates IV-*a*, IX-*b*), is a large tree, frequently of majestic proportions, often attaining a height of 15 to 30 meters, and has a trunk exceeding 1.5 meters in diameter. In habit the bauno is more upright with a taller trunk, and the branches are rather more gnarled and more sparsely foliaged than those of the mango. The leaves are from 12 to sometimes exceeding 23 cm. long, elliptical to lanceolate or oblanceolate, leathery, smooth, with a prominent midrib. The flowers are small, lilac-blue to pinkish, otherwise very similar to the flowers of the mango, but are assembled in smaller and more compact terminal panicles.

The fruit from individual trees is quite variable, from small, with scant fibrous flesh and a large seed, to somewhat larger than a good Carabao mango, from 11 to sometimes exceeding 13

centimeters in length, and 7 to 8 centimeters at its greatest equatorial width, oblong-obovoid; the stem is long, usually inserted obliquely at the base in a more or less irregular sinus; the stigmatic area is depressed; the surface is smooth and the color yellowish green; the lenticels are numerous and small; the skin is very thin and brittle, adhering closely to the flesh; the flesh is white, very juicy, subacid, rich, quite aromatic, and in the best forms of excellent flavor, partaking somewhat of the flavor of the guanabano and the apricot combined. The seed is large, ellipsoid-elongate, somewhat flattened, monoembryonic, and encased in a mass of coarse, matted fibers that penetrate into the flesh more or less according to the individual seedling tree.

The bauno ordinarily blooms from June to August and the main crop ripens in August to October.

While the foliage characters of the bauno are quite distinct as compared with all other species of *Mangifera* seen by the author, the seed differs even more from those in the other species both in its ellipsoidal form and in the absence of a distinct husk. All attempts to graft the bauno on the mango at the Lamao Experiment Station have failed, showing that the physiological affinity between the two species is rather remote.

The bauno is always a striking tree with its tall, straight trunk, but is especially impressive during the flowering season, when the crowns appear one blazing mass of color, visible at a long distance.

The bauno grows well even on periodically inundated land and requires a rainfall of even distribution throughout the year in order to succeed; and the tree is especially recommended for planting in Laguna, Tayabas, the Bicol provinces and the moist Visayas where the mango does not thrive, or rather does not fruit—and, of course, that part of the Archipelago where the tree is already established. The tree is a stately ornamental and suitable as a shade tree for country roads, and for windbreaks.

The bauno is found in a wild state in the Malay Peninsula, where it is known as Binjai, and in the Sunda Islands where it is variously known as Bindjai, Binglo poetih, Kemang Bindje, Isem, Limoes, Wani, Taloe, Wangal, and Binglo. A form with light-brown skin and sweet flesh is reported from Singapore. In Java the tender leaves and the seeds are eaten in addition to the fruits.

In the Philippines where the bauno was first described as *M. verticillata*, the tree occurs in the Sulu Archipelago, Mindanao and Basilan from sea-level up to an elevation of about 450 meters, so far as known, and in especially great numbers on the Island

of Jolo, on Basilan, and near Butuan in Agusan, Mindanao. A "forest" of bauno trees is reliably reported to be located at Momungan in Lanao Province on the same island. While it may be that the tree is indigenous to the Philippines, it is of interest to know that the Sulus have a tradition that it was introduced by them to Sulu from the countries in the west.

The HUANI, *Mangifera odorata* Griff. (Juani, Juany, Juanita, Wannih, Kandopi) (Plate IV-*b*), is a medium-sized tree, in the Philippines rarely exceeding 15 meters in height so far as observed, and is so similar to the mango in habit and foliage as to be easily mistaken for that species which, however, it does not equal in size of trunk and spread of crown. The flowers are similar to those of the mango except that the petals are whitish with purple markings and are congregated in rather small panicles, rarely more than 14 centimeters long.

The fruit is of about the size of the average mango, but shorter, with full cheeks and but slightly flattened; the color is dark green with a few large lenticels; the skin is very thick and tough; the flesh is yellowish, sweet, juicy, very resinous and very fibrous, with a pungent, disagreeable odor; the seed is similar to a large plump mango seed and is covered with abundant coarse fibers, frequently polyembryonic.

The huani is a native of Malacca and Java and undoubtedly is found in the other Sunda Islands. In Java the huani is cultivated to some extent by the native inhabitants under many names, among which Bembem and Kweni are perhaps the most common, and is known as Kohini in Singapore.

In the Philippines the huani is found on the south coast of Mindanao, in the interior of Cotabato, in Basilan, and in the Sulu Archipelago, and may be a native of the Philippines, though as in the case of the mango and bauno, the Sulus have a tradition that the tree was introduced by them.

"Sangay" is a variety of the huani found in Jolo, the fruits of which are yellowish when ripe but otherwise similar to the huani.

To the uninitiated the huani with its strong, resinous flavor and profuse fiber is a poor substitute for the Carabao mango, but the palate once accustomed to it many people profess a preference for the huani.

The huani has been budded on the mango, on which it makes a very satisfactory growth.

The numerous huani trees in Zamboanga and on some of the dry islands in the western part of the Sulu Archipelago would seem to indicate that though the huani loves a fairly heavy

rainfall of equal distribution throughout the year, it will grow even with a moderate rainfall, say 1,200 millimeters per annum, provided there are no dry periods.

The BACHANG, *Mangifera foetida* Lour., is a large tree, reported to attain a height of 30 meters, bearing a large, edible fruit with a pungent, disagreeable aroma.

The tree occurs from Cochin China throughout the Malay Peninsula to Java, in which island it is cultivated to some extent under the names of Batjang, Isem, Limoes, Limoes tipoeng, and Bawang.

As growing at the Lamao Experiment Station from material received from Dr. I. H. Burkill, Director of the Botanic Garden, Singapore, the bachang appears to be very closely related to the huani.

The bachang thrives the best where the rains are abundant and well distributed throughout the year.

The KOSHAM, *Mangifera sylvatica* Roxb., is a large tree, native of India, very similar to the mango. According to Roxburgh the fruit is nearly as large as a mango, ovoid, obliquely acuminate, and yellow in color. The seed is oblong and less fibrous than in the "common" mango in India. The fruit is eaten by the native inhabitants though in quality and flavor it is said to be inferior to even a "bad domestic mango."

There is probably but little difference in the eating quality of the kosham and the Philippine paho.

The kosham flowers in October and has ripe fruit in February and March.

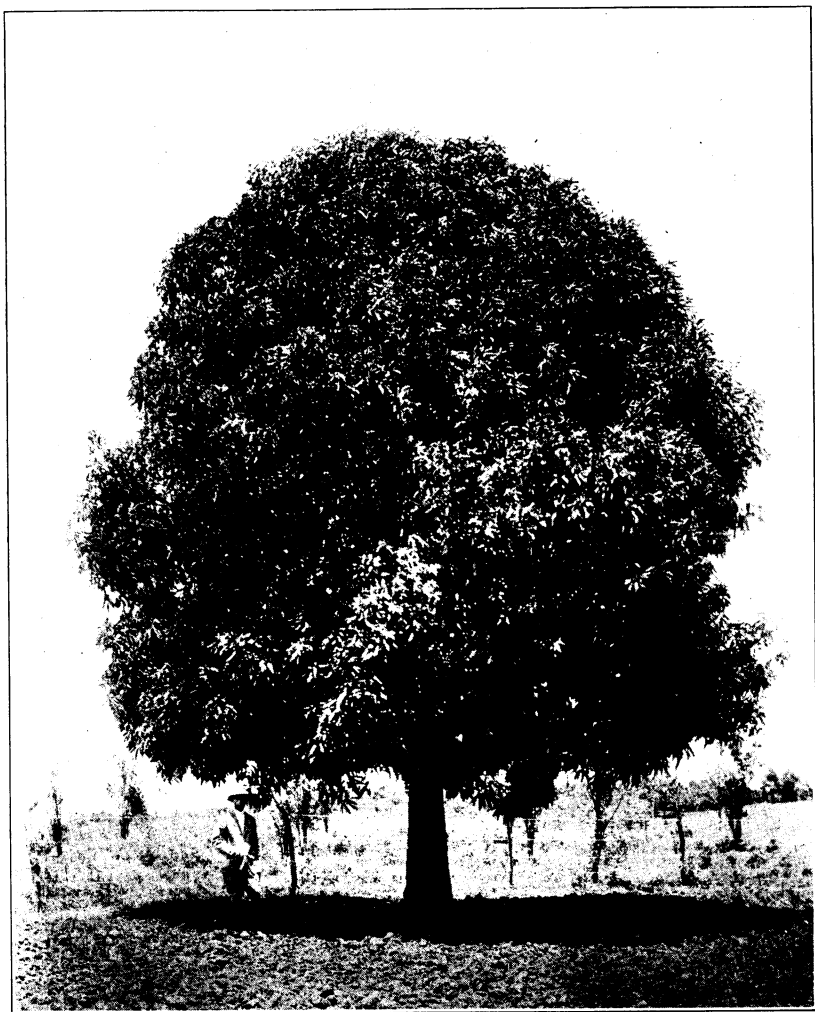
The PAHO, *Mangifera altissima* Bco. (Bunutan, Malapaho, Pahutan, Pahuhutan, Pangmangaen, Popowan), is a large, rather attractive tree, 15 or more meters high, of more upright habit than the mango, of wide distribution in the Philippines.

The fruit is 5 to 8 centimeters long and 4 to 6 centimeters in cross-section, semi-reniform, smooth, green to yellowish with fibrous, resinous, acid flesh.

The fruits are gathered in the forest and pickled in brine and eaten. The tree is not cultivated.

The fruits of Landjoet, *M. lagenifera*; Langoeng, *M. langang*, and Asam Koembang, *M. similis*, are known to be eaten by the native inhabitants where they grow, but no descriptions of these fruits are available.

Other species in the genus besides the paho occurring in the wild state in the Philippines are *M. monandra* Merr., found from Northern Luzon to Leyte under the names of Karig, Kurig, Ma-



Carabao mango tree, illustrating its usefulness as a shade tree

lapaho, Paglumbayan, Pagsagon, Pao, and Pounan; and *M. longipes* Griff., recently collected in Palawan under the name Apale.

Among the many other species of *Mangifera* none are reported to bear edible fruits, though *M. caloneura* Kurz., in India is said to bear a yellowish, subacid fruit 5 to 6 centimeters long; *M. oblongifolia* Hook., in Malacca, a fruit 10 centimeters long; and *M. macrocarpa* Bl., in Java and Malacca, a large, acid, bitter fibrous fruit as large as an infant's head.

THE EMBRYONY OF THE MANGO

The seeds of most plants are monoembryonic, i e., each seed produces only one plant. In some plants, however, like the orange, *Citrus sinensis* Osb., the mandarin, *Citrus nobilis* Lour., and the yambo, *Caryophyllus jambos* Stokes, the seeds are also frequently polyembryonic, i e., one seed may contain several embryos, each of which, under favorable conditions, is capable of producing a plant. The mango is both mono- and polyembryonic, the seeds of the latter type frequently producing six to eight plants, and as many as thirty have been observed to come from one seed.

In the Philippines, Florida, Cuba, Porto Rico, and Jamaica, the observation has been made that the seedling types, all being polyembryonic, transmit their characters to their progeny in a remarkable degree—in the vernacular “come true to seed.” Of course variation exists but the main characters of a type are well reproduced. Belling³ in an investigation of the seeds of a polyembryonic type in Florida, found no formation of embryos from the germ cells in the ovaries, and all the embryos seen were adventive.

As the Indian mangos fruited in Florida it was noted that the seeds were monoembryonic, and with one exception subsequent observations in Florida and the West Indies have shown this to be a constant character in all Indian mangos that so far have fruited there. A highly variable progeny appears to be a correlative feature in the monoembryonic mangos. Kinman,⁴ speaking of the fruiting seedlings of the Cambodiana, Amini, Bulbulchasm, Sandersha, and Totapari, all imported Indian varieties, says:

“Among these varieties none except the Cambodiana bore

³ Annual Report, Florida Agricultural Experiment Station, 1908, pp. 109–125.

⁴ Annual Report, Porto Rico Agricultural Experiment Station, 1917, pp. 21–22.

fruit which resembled the parent variety at all closely either in external character, in flavor or in color of flesh, and all except the Cambodiana had a high content of long, tough fiber, while the parent fruits were practically free from fiber."

He concludes by stating that excepting the Cambodiana, none of these varieties are adapted for propagation by seed because of their variability. It should be mentioned in this connection that the Cambodiana is polyembryonic and originally came from Saigon, and is very similar to the Philippine Carabao.

In the same connection Mr. Hartless' statement in a recent letter to the author that "So far as our Indian mangos are concerned I have never seen or heard of a case of polyembryony, and I have seen many thousands of seedlings," is of exceedingly great interest as confirming the observations of other students of the behavior of the Indian mangos abroad. It is also remarkable in that it would imply that at least in that part of India familiar to Mr. Hartless all mangos are monoembryonic. Popenoe states that he has seen the monoembryonic Mulgoba revert to polyembryony in the first generation in Florida.⁵ So far the only recorded instance.

If this observation is found to be general among the Indian varieties, and is not an isolated case, the mangos cannot be segregated in a monoembryonic and a polyembryonic group as a basis for future classification of the mango as suggested in the former edition of this bulletin.

THE CLASSIFICATION OF THE MANGO

Of less importance to the planter the classification of the many mango varieties, groups and races is of great interest to the systematic pomologist. In India such classifications have been artificial and arbitrary, while the contributions by Americans tend towards a natural system of classification. In all instances these classifications so far have been limited to observations within the countries of the respective writers with but little or no material from other regions. Of undoubted value in the immediate locality concerned, in a broad sense classifications based upon the study of a limited number of types are apt nevertheless to be of little significance and to require reconstruction when the mangos of all lands are considered. Therefore, in order that the work may be comprehensive and enduring and not subject to revision, with the inevitable attendant confusion,

⁵ Proc. American Pomological Society. Session 1917, p. 71.

not only should a classification include the mangos in India and the West Indies but the numerous forms that grow in Africa, Indo China, and Siam, Malaysia, Australia, the Pacific Archipelago, and Central and South America. This work should include a study of the nomenclature of the varieties cultivated in India, including their merits from the view point both of the planter and the manufacturer of canned and preserved mangos.

THE MANGO IN THE PHILIPPINES

INTRODUCTION

The early navigators who discovered the Philippines do not refer to the mango. It is true that Pigafetta, who accompanied Magallanes, mentions very few fruits of any of the countries he saw on the voyage during which he visited the Philippines, still, his silence in regard to the mango can not be regarded otherwise than as significant, considering that he visited the Islands in March and April, probably leaving the first days of May, during which time the early mangos must have been in season, had the mango existed here. Still more so is the fact that it is not referred to by Antonio de Morga in *Islas Filipinas*, a work published in 1609, republished with annotations by José Rizal in 1890, while he mentions such fruits as the banana—of which he speaks of twelve varieties—the orange, citron, lemon, papaya, guava, custardapple, tamarind, jak, mabolo, santol and pili. The probability that the mango was not yet introduced into the Philippines until after 1600 is strengthened by the fact that de Morga, who lived in the Archipelago for a number of years, speaks of “paos,” a small, green fruit, like a nut, that is eaten as a pickle and has a good taste when well prepared. This is evidently the fruit of *Mangifera altissima*, which still is known under the name paho, and is pickled and eaten. We can not but conclude from this, considering his description of the fruit, the absence of all reference to the quality of the fruit “paos” in its natural state and that he was not even familiar with the word mango, that the mango was in his time still unknown in the Philippines. Mercado, who was born in 1648, prepared a manuscript, probably between 1680 and 1690, on Philippine plants entitled, *Libro de Medicinas de esta Tierra*, that was published in 1880 in Blanco's *Flora de Filipinas*, Volume IV. A fruit called “paho” is here referred to as being preserved with salt, oil, vinegar, etc., but

there is no description of the fruit to indicate the species; Mercado says that "they are called mangos by the Portuguese." This is apparently the first time the word mango is used in Philippine botanical literature and then only in an explanatory sense. It would seem certain that this fruit was one of the native species of *Mangifera* were it not for his remark relative to their "famous taste" on ripening, and if this fruit is the mango, the reference to it indicates that, a newly introduced fruit, it was still compared with the native wild paho and prepared in a similar manner. This theory would seem to be substantiated by the statement of Dr. Gemelli Careri, who visited the Philippines in 1697, and says: "There are also mangos from Siam, brought out of late years." Dampier,⁶ who visited the Philippines in 1687, says: "The mangos here grow as big as apple trees—the fruit is as a small peach, but long and smaller toward the top. It is of a yellow color when ripe, very juicy, and of a pleasant smell and delicate taste." It is true that Dampier says that the mango grew wild in the larger islands, but not being a naturalist it is probable that he confused the mango with one of the native species of *Mangifera*, which in habit and foliage much resemble the mango. Delgado,⁷ who finished this work in 1751, speaks of the introduction of the mango from Macao but fails to mention a date even tentatively. G. J. Camello, who came to the Islands in 1688, prepared a manuscript on the plants of the Philippines that was printed as an appendix in Ray's *Historia Plantarum*, Volume III, published in 1704. Camello, in this work, names six varieties of mangos, appending short descriptions thereof, none of which are known today except the Chupadera and were probably invented by him for the occasion. He speaks of several other fruits in the same connection, some of which may be native species of *Mangifera*. No reference is made to the probable time of the introduction of the mango.

From the above data it may be concluded that the mango was introduced not later than about 1675 nor earlier than about 1600, and probably between the latter date and 1650.

The largest mango trees in Luzon are those in Cavite Province and some large specimens in Binacayan are claimed to be the oldest.

The above statement relative to the introduction of the mango in the Philippines, was written in 1911 and applies to the Island

⁶ Dampier, W. A., *New Voyage Around the World*, 1703, Pt. I, p. 391.

⁷ Delgado, J. J., *Historia de Filipinas*, 1892, p. 502.



(a) Bauno, *Mangifera catesia*, on Basilan



(b) Huani, *Mangifera odorata*, Zamboanga

of Luzon, the Visayas and the north coast of Mindanao. Since then the author has also had the opportunity to study the mango grown in the Sulu Archipelago and the territory in Mindanao settled by the Moros. The mango trees grown in this region, in Lanao, Cotabato, Davao, Zamboanga, and Sulu, are quite different in habit and the fruit is likewise so distinct from those in the north of the Archipelago as to indicate very plainly a different origin. The Sulus have, in fact, a tradition that a certain rajah, one Ahmat Ansang, sailed to the country of the Malays and brought back seeds of the "Mampalam, *Mangifera indica*, Wannih, *Mangifera odorata*, Baonoh, *Mangifera caesia* and the Marrang, *Artocarpus odoratissima*."

In the Dutch East Indies some mango forms are known under the name Dodol, very evidently identical with the Dudul mango in Mindanao. In this connection it is also interesting to note that Salikaya is the Moro name for *Annona reticulata*, the same as given for this species by Rumphius from Amboina. On the other hand one of the names of *M. caesia* in Java is Wani. While apparently a variant of this name, Wannih, Juani or Huani is applied to *M. odorata* in Sulu and Mindanao.

Since the first Mohammedan missionary arrived in Sulu, about 1380 A. D., after which date there was more or less frequent intercourse between the Malay people in the west and south-west of the Philippines and the Mohammedan region of the Philippine Archipelago, it seems probable that the introduction of the mango into Sulu and Mohammedan Mindanao antedates its arrival in Luzon and the Visayas—possibly by 200 years, or even more.

In 1911 a large collection of grafted mangos were imported from India and set out at the Lamao Experiment Station. Among these the following varieties have become well established, but have not yet fruited.

Naspati, Gopalbogh, Tamancha, Krishnabogh, Sanduria, Chickna, Bombay green, Alfonso, Malda, Kachamitha, Davy's favorite, Langra, Kutna, Salibunda, Sufaida, Kakaria, Surkha and Najibabadi.

Cavite, Nueva Ecija, Bulacan, Pampanga, Pangasinan, Cebu, Bohol and Iloilo lead in the production of mangos in the Philippines.

Notwithstanding the great natural advantages to the fruit culturist, at present the mango industry in the Philippines can scarcely even be said to be in its infancy. The trees nearly always are planted on the edges of the rice fields and where

other crops can not be cultivated.^a Notwithstanding this neglect, the mango thrives everywhere, as witness the many enormous trees 1.5 meters or more in diameter and exceeding 18 meters in height (see frontispiece), and from which in some years large crops of fruit are gathered. Still, these trees produce only a small tithe of fruit compared to their normal bearing capacity. This is due partly to the mango hopper, which periodically appears in great swarms and destroys the bloom, and it is probably partly caused by neglect, but by far the greatest reason for the unproductiveness of the trees is believed to be the fact that all are seedlings. A census taken in the summer of 1911 in a mango orchard in Muntinlupa, Rizal, showed that only 8 per cent of the trees bore a heavy crop of fruit, 15 per cent bore moderately, 28 per cent had a poor crop, and 49 per cent of the trees were unproductive. Only 23 per cent, or less than one-fourth of the trees, yielded a satisfactory return. Since these trees had suffered but little from insect attacks at the time of blooming, they were fairly representative of the mango throughout the Archipelago. Judging from the observations made in other mango-producing districts similar conditions prevail there. While this tendency to sterility in a large percentage of the individual seedlings may be accentuated in the mango it is not peculiar to this species alone but extends to many others. It is because of this same well recognized trait in the fruits grown in the temperate zone that, coupled with other reasons, these fruits are always propagated vegetatively, by budding, grafting or as cuttings. Nor can mango growing become a truly big industry until grafting has become a recognized standard practice in the management of the mango orchards. The advantages derived from the budding and grafting of the mango are further discussed under the chapter on propagation.

^a There are two notable exceptions to this practice. One is a mango orchard planted on a friar estate in Muntinlupa, Rizal, perhaps some 40 years ago, in its prime consisting of possibly 2,000 bearing trees. They have since been neglected and there are now probably not more than 500 trees alive in this orchard.

Another mango plantation in the making was started by Governor F. W. Carpenter in 1912 in Novaliches, Rizal. This mango orchard has been gradually extended until it covers an area of perhaps 200 hectares, including young plants set out during the current year. All these trees are seedling Carabaos and Picos, but they will be top worked to selected Carabao varieties.

SEEDLING TYPES

Pomologically speaking, a variety may be defined as a group of plants propagated vegetatively from the original plant, producing fruit of a distinctive appearance, texture, flavor, or aroma, by which characteristics it may be distinguished from fruit of other trees of the same species. Some of the botanical characters of the plants also may be distinct from those of other trees. In the Temperate Zone, where fruit growing has been well systematized and has become an established industry, this interpretation is well recognized.

Among the tropical fruits in America the mango, unlike the banana and pineapple, has not been grown on extensive areas or for an exacting and discriminating market; and in the past there has been no very great demand for a sharp demarcation between its varieties as there is among the deciduous fruits. In consequence the seedling types, that heretofore have been generally grown and which reproduce themselves remarkably well from seed, have been called varieties. This is equally true of the mango in the Philippines and in other parts of the world where it is cultivated. These conditions are, however, gradually changing wherever the mango becomes the object of systematic culture and study, and the erstwhile "varieties" in the next few years should, here as elsewhere, become races, groups and types.

In the introduction of the Carabao and the Pico the Philippines were singularly fortunate in contrast to other parts of the Tropics where the mango, as here, was introduced by seed, in that these two forms, the fruit of which is of remarkably good quality, are polyembryonic and reproduce themselves true from seed (a feature of great value in a fruit which is not propagated vegetatively).

According to our present knowledge there are six distinct forms of mangos in the Philippines—the Carabao, Pico, Dudul, Binoboy, Señora, and Pahutan, which are important in the order of their enumeration.

The Carabao is the mango most esteemed and most generally planted in the mango districts in Cavite, Nueva Ecija, Pangasinan, Pampanga, Bulacan, Cebu, Bohol, and Iloilo. The Pico is second in importance throughout Luzon and the Visayas. The Dudul is the most esteemed mango in Cotabato and Lanao. The Titi is the most common mango in Zamboanga, Jolo and Davao and is also abundant in Cotabato. The Binoboy is found in the "highland" of Cavite, about Silang and Indang, but is comparatively scarce and of little importance. The Señora is another

type of which there are quite a number of trees both in Cavite and Bulacan, but this also is an unimportant form that like the Binoboy never appears in the Manila market. The Pahutan trees attain large dimensions but the fruit is small and held in but little esteem, and rarely seen except in small village markets.

Cavite and Cebu generally have the reputation of producing the best mangos in the Philippines, but the mangos of Iloilo, Bohol, Bulacan and Pangasinan are also of such exceptionally good quality that it would be difficult indeed to award the palm to any one at the expense of the other provinces.

DESCRIPTIONS OF THE PHILIPPINE MANGOS

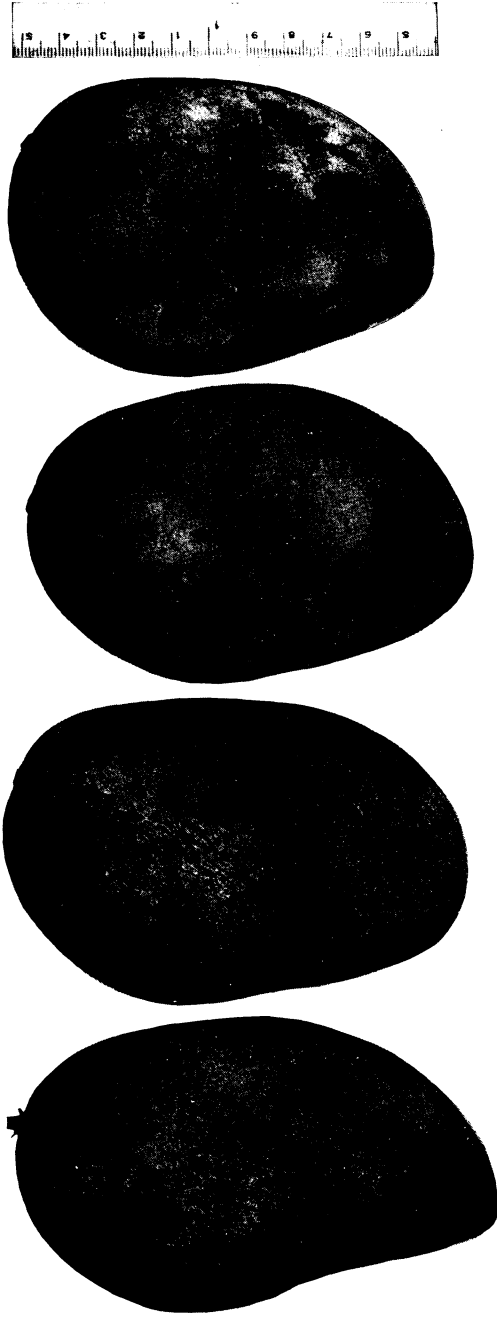
CARABAO (PLATE V, VIIa)

Size medium to quite large, length up to 125 millimeters, breadth up to 85 millimeters, average weight 230 grams with a maximum of 560 grams; form quite variable from short-oblong with a blunt apex to rather elongate and pointed, asymmetrical, flattened, but with full cheeks; ventral shoulder usually prominent; dorsal shoulder short; stem inserted square or oblique; base rounded; beak rather indistinct and variable, sometimes coinciding with apex; nak about 15 to 25 millimeters above apex, usually not prominent; surface smooth; color yellowish tinged with green; lenticels light yellow, usually sparse at basal end of fruit, abundant on apical portion; skin medium thin, tough; flesh yellowish, paler than in the Pico, very tender and melting; flavor very delicate, aromatic and spicy; fiber medium coarse, short, confined almost entirely to edges of seed; seed oblong with a blunt pointed, frequently a truncate apex, medium large to small and thin, normally polyembryonic.

The similarities in the fruit and trees of the Carabao and the Cambodiana, introduced into Florida from Saigon, Cochin China, are so many and great that the two forms would seem to have a common parentage, or to have sprung one from the other; this fact, perhaps, may also indicate the original home of the Carabao mango.

The tree is of vigorous growth with fruit mostly ripening from the latter part of May through June and the early part of July. But, by means of firing, the Filipinos, especially in Cavite, force the trees into fruiting as early as January, though this early fruit is not so finely flavored as that produced in the ordinary season. As a matter of fact, a few mangos are found in the market during nearly all the months of the year.

At its best the Carabao is easily the premier fruit of the Philippines, and it is doubtful if any of the celebrated East



Carabao mangos, illustrating variation in the fruit

Indian mangos are quite equal in flavor and quality to the Carabao. Apparently it is quite resistant to the fruit flies that are now present in the Archipelago or the losses from this pest would certainly be greater than they are.

The so-called Corazon is a form of the Carabao, found here and there in Cavite. The fruit is smaller than the Carabao, averaging 220 grams with a maximum of 260 grams. In general outline and other characteristics the Corazon resembles the Carabao though frequently the fruit is somewhat heart-shaped (whence the name) and is not quite equal to the Carabao in flavor and quality. The seed is proportionally large, quite plump, and is polyembryonic. The trees are comparatively small, but very productive.

Because of their productiveness and dwarf character selected seedlings of the Corazon are well worthy of propagation and dissemination.

Pico (Synonym: Padero) (Plate VI, VIIb)

Size medium to fairly large, length up to 125 millimeters, breadth rarely more than 80 millimeters, average weight 215 grams attaining a maximum weight of 460 grams; form oblong, semi-reniform, asymmetrical, more distinctly flattened than the Carabao; stem inserted squarely or obliquely; base rounded; ventral shoulder usually prominent, sometimes compressed toward base; dorsal shoulder short frequently almost wanting; apex rounded; beak distinct; nak usually well above beak; ventral side above beak nearly always more or less concave; surface smooth; color a light orange netted with brownish veins; lenticels pale yellow, sometimes almost entirely absent except at apical end; skin thick and tough, a thick coating of flesh adhering; flesh a rich orange yellow, nearly always assuming a reddish tinge at apex; tender, but not melting like the Carabao, more rich and sweet than the fruit of that type, but having less than the Carabao of the spicy delicate aroma that distinguishes the Carabao, and which makes this perhaps the best flavored mango in the world; fiber fine and short, confined almost entirely to the edges of the seed; seed long, quite thin, medium large. Normally polyembryonic.

The tree is of vigorous growth. The fruiting season lasts from May to July.

The fruits of the Pico are not infrequently defective because of hard, lumpy, inedible growths in the flesh of the fruit, the cause of which is unknown. This trouble has never been observed in any other mango in the Philippines.

The Cabayo is a mango tree growing in Silang, Cavite, with quite distinctive fruits, yet plainly indicating its descent from the Pico. The fruits are of medium size, averaging 256 grams with occasional ones attaining 280 grams. In form it is oblong oblique, slightly flattened, pronouncedly concave on the lower ventral side and having a distinct beak; skin rather thin but tough; flesh light orange yellow, juicy, quite rich and sweet with a fair degree of acidity; fiber short, seed medium large.

DUDUL

Size small to medium; form short-oblong, about 90 millimeters long and 60 millimeters across in its broadest dimension, with full cheeks; surface smooth; color yellowish green to greenish yellow with a faint blush on the sun-exposed side; skin thick and tough like that of the Pico; flesh a deeper yellow than in the Carabao, firm, with rather abundant fiber, resinous, yet very sweet and of good flavor, seed large and fiber rather abundant.

In eating quality the Dudul is rather superior to a good No. 11 mango in Florida. Well esteemed in Cotabato and Lanao where it is grown, it is greatly inferior to the Carabao and Pico. It is possible that in common with Titi the Dudul is more prolific in a moist climate than is the Carabao and Pico. For this reason local trees of unusual merit may be worth propagating vegetatively.

BINOBOY (Plate VIIIa)

Size medium large, length up to 135 millimeters, breadth up to 55 millimeters, weight averaging 252 grams with a maximum of 300 grams; form oblong and slender, almost cylindrical or very slightly flattened, sometimes with a slight concavity on the ventral side; base rounded to compressed with narrow shoulders; the ventral frequently wanting; apex rather pointed; not equal or indicated by a slight swelling well above the apex; surface smooth; color greenish yellow to yellowish green with a faint reddish blush on sun-exposed side; lenticels medium, pale yellow; skin moderately thick, tough; flesh light orange yellow, very juicy, melting, subacid; flavor and aroma medium; fiber scant and fine, confined mostly to the edges of seed. Seed long and quite full, polyembryonic.

The Binoboy is found only in the "highlands" of Cavite about Indang. The trees are reported to be very prolific, but the fruit is of poor keeping quality. The fruit is remarkably acid for a Philippine mango and is said to make a very good jelly.

Eaten out of the hand the Binoboy is very inferior to the

Carabao and the Pico and is not recommended for general culture.

The fruits of the Binoboy never appear in the Manila markets.

SEÑORA (PLATE VIIIb)

Size medium to fairly large, average weight 316, attaining a maximum weight of 480 grams; form obliquely reniform to heart shaped with full cheeks, yet quite distinctly flattened; shoulders poorly developed; stem inserted in a distinct shallow cavity; apex frequently ending in a distinct sharp-pointed beak with a more or less pronounced concavity above; surface smooth; color lemon yellow; lenticels nearly absent; skin thin to medium thick; flesh straw yellow, juicy and melting but not rich, with a fair degree of acidity; seed small and thin, almost devoid of fiber, polyembryonic.

A considerable number of Señora mango trees are reported to grow in Cavite at varying elevations and also in Bulacan, but they are poor croppers and the fruit is very susceptible to decay (and possibly fruit flies), hence the fruit never appears in the markets of Manila.

The proportion of edible flesh is estimated to be considerably greater in the Señora than in any other mango grown in the Philippines but because of the defects mentioned coupled with inferior eating qualities as compared with the Carabao and the Pico, the Señora is not recommended for cultivation.

There are other local types of mangos in Cavite and Rizal called Señora, though merely slight variations of the Carabao and not sufficiently distinct to be classed as types. The more marked and superior forms could more properly be propagated under varietal names.

PAHUTAN (PLATE IXa)

(Synonyms: Supsupen, Chupadero)

Size small, length up to about 90 millimeters, breadth 45 millimeters, weight averaging 90 grams, with a maximum of 120 grams; form oblong oval, asymmetrical; stem inserted obliquely; base rounded; dorsal shoulder usually short and sloping; ventral shoulder fairly prominent, apex sloping toward beak; this usually an obtuse point, not frequently coincident with apex; nak slightly elevated, well above apex; surface smooth; color orange yellow tinged with green and finely netted with brownish veins, or the fruit matures green; lenticels small, buff yellow, mostly toward apex; skin moderately thick, tough; flesh pale orange yellow, tender, very sweet, rich and aromatic; fiber medium coarse, profuse; seed large, polyembryonic.

Season of maturity the latter part of May, June, extending into the early part of July.

Because of its small size, large seed and excessive amount of fiber the Pahutan is of no commercial value. The trees are exceedingly vigorous, frequently with a trunk measuring 1.5 meters in diameter and 15 to 18 meters high. The Pahutan might be of value as a stock for the commercial varieties.

The Pahutan as described above is found mostly in Cavite, Rizal, Batangas and western Laguna.

The Titi mango found in Mindanao and Sulu is for all practical purposes a form of Pahutan, but stouter in proportion to the length, and has a broadly rounded apex. It always ripens green or greenish yellow. The tree is smaller than that of the Pahutan in Luzon. Though similar to the Pahutan the Titi is undoubtedly a separate introduction.

Among the Philippine mangos the Carabao and Pico are so superior to all other forms that for general utility purposes no other of the "native" kinds should be planted. They may be depended upon to come true to type from seed, and so are remarkably uniform. Still, there is considerable variation within the type, and a careful study of the numerous seedlings in the great mango districts in Cavite, Bulacan, Cebu and other provinces would bring to light varieties which in all respects are superior to the ordinary Carabao and Pico. The recent mango exposition in Manila furnished ample proof of what might be accomplished in this line.

It seems very probable that the Carabao, Pico, Pahutan, Dudul and Titi were originally introduced into the Philippines and that from them have mutated the other forms described above, as well as others of which scattered trees are found here and there, such as Pahut (a large form of Pahutan), the Paho (a true mango, not *M. altissima*), Cabayo, Bulac, etc.

No budded varieties of the Carabao or any other of the Philippine forms have as yet been established, named and described.

THE MANGO IN FLORIDA, HAWAII, PORTO RICO AND CUBA

It is about ten years since any considerable number of the grafted Indian mangos came into bearing in Florida, Hawaii, Porto Rico and Cuba, but the arrival of these varieties, coupled with the improvement in the grafting practice has not brought about the progress then anticipated.

It is estimated that about 40 hectares are set out to grafted mangos in Florida, where the Haden is the leading variety. Other popular sorts are the Amini (Plate Xa), Cambodiana



Pico mangos

(Plate Xb), Sandersha (Plate XI), and Pairi. The Mulgoba, once the leading variety, has fallen into the discard because of its shy bearing propensities and the trees are being top-worked to other varieties. Inarching is still practiced but shield budding is fast gaining the lead among the more progressive growers and nursery men of the State. One variety of merit, the Haden, has originated in Florida.

In Hawaii there are large numbers of seedling trees of the ordinary fibrous kinds but very few have been top-worked to the imported varieties. Of these the Pairi, in Hawaii known as the Pirie, has taken the lead, and the Cambodiana is a close second. The other principal varieties grown include the Kavashi Patel, Amiri, Mullgoa, Alphonse, Jamshedi and Sandersha. The Pairi and Cambodiana especially have grown in favor, since, after the introduction of the Mediterranean fruit fly, *Ceratitis capitata*, they were found to be resistant to this pest. They have also been found highly resistant to the attacks of the black spot on the fruit caused by anthracnose, *Colletotrichum gloeosporioides* Penz. Shield budding is practiced, but the more common method employed in top-working old trees is crown grafting, known there under the name of bark-grafting, the grafts being enclosed in Manila paper bags to prevent the escape of moisture until they have taken. The more serious mango pests in Hawaii include the Mediterranean fruit fly, the mango weevil, *Cryptorhynchus mangiferae*, and the anthracnose, which last is most destructive in the humid districts.

The situation in Porto Rico is quite similar to that in Hawaii except that there are larger numbers of seedling trees which also have bigger dimensions. Very few have been top-worked to the fiberless, imported kinds. Of these the Cambodiana, Pairi, Totapari, Amini, and Bennett have been found the best. Among them the Cambodiana and Totapari are most susceptible to the American fruit fly, *Anastrepha fraterculus*, perhaps the most serious mango pest in Porto Rico.

The mango is the leading fruit in Cuba. Long ago the tree became naturalized in this island, and there are a large number of enormous seedling trees, including several quite distinct races, all of which are more or less fibrous and resinous except the "Filipino," a seedling race undoubtedly of Philippine origin, the fruit of which is very similar to a long, slender Carabao. The leading types are, however, the Criollo and Manga, the latter of which is immune to the American fruit fly, the most serious mango pest in Cuba. The Biscochuelo, Señora, Corazon, Toledo, Chino and Mameyson are other more or less important seedling

types. The Mulgoba, Cambodiana, Perrine, Haden and various other fiberless kinds have been introduced from Florida, and some 30,000 trees of these varieties are now said to be growing in the island. The top-working of seedlings to improved varieties is slowly gaining headway. Shield budding is used but inarching is also employed in nursery practice.

Aside from the fruit fly already mentioned, the red spider, *Tetranychus bimaculatus* Harv., and two species of thrips *Sele-nothrips rubrocinctus* Giard, and *Heliothrips haemorrhoidalis* Bouché, at times are troublesome in Cuba. As in Hawaii and Porto Rico, anthracnose is the most serious disease of the mango.

GRAFTED VARIETIES IN INDIA

The mango was first grafted in India a long time ago and a very large number of varieties are cultivated there. Many of these varieties are of excellent quality, and some, which have been introduced into the tropical and subtropical territories of the United States and in Cuba, are beginning to supplant the inferior mangos commonly grown there. However, it would seem that a very large proportion of the Indian mango varieties are horticultural curiosities rather than sorts of commercial merit, and while the importation of the best kinds cannot be too highly recommended, the introduction of others would appear to be of doubtful value. Among the varieties introduced into the United States the Amini, Bennett, Cambodiana, Totapari, Sandersha, Bulbulchasm, Pairi and Sufaida No. 1 have been found to be the most desirable, but there are unquestionably many others that will be found equally good. It is well to remember, however, that local climatic and soil conditions exert more or less influence over a variety and it is not necessarily true that because a variety is a success in Florida, for instance, it will be a success in the Philippines.

The following varieties are especially recommended for introduction: Amini, Alfonso (several varieties), Bennett, Bombay (several varieties), Bulbulchasm (as fruited in Porto Rico), Cambodiana, Faquirwala, Fuzli, Haden, Hathijuhl, Kalapahar, Kohitur, Langra (several varieties). Pairi, Sandersha, Shar-bati Black, Singapuri, Sufaida No. 1, Durma, Gopalbogh, Amiri, Khaparia, Shapusund, Surkha, Totapari.⁸

⁸ For descriptions of these and a large number of other Indian mango varieties consult "A descriptive List of Mango Varieties in India," *Phil. Agr. Review*, Vol. XIII, No. 4, 1920.

THE MANGO AS AN ORNAMENTAL TREE

Aside from its value as an economic plant, the mango when full grown is one of the most majestic and ornamental trees in the Tropics, and for this reason it may be utilized to advantage in laying out a park or garden. It is singularly effective as a solitaire on the lawn, and is also suitable as an avenue tree (Plate III). When used for the latter purpose it should be kept in mind that the various types differ in habit, and for the best effect all the trees should therefore be seedlings of the same type, preferably those with tall trunks and upright habit. If budded trees are used in an avenue, varieties of upright vigorous growth, with tall, straight stems should be selected.

CLIMATE

The mango grows from sea level to an elevation of 1,200 meters within the Tropics. In a commercial venture it is doubtful if the culture of the mango would pay at an altitude much beyond 450 meters, though the fruit is well worth growing for home consumption up to at least 700 meters. In the subtropics its cultivation may be extended to the north and south well beyond the frost line, provided the trees are protected from the cold during occasional frosty nights. From the data accumulated by Hartless in Saharanpur, North-Central India, the varieties differ in hardiness, and while practically no information seems to have been gathered on this subject it is probably true that some varieties require a sea level climate for the best development of the quality of the fruit, and are sensitive to even a slight increase in elevation, as is said of the Carabao. Others may be at their best at higher elevations. There is a vast field here for experimentation.

The tree will flourish under abundant rainfall throughout the year, but for fruit production the mango cannot be grown where much rain falls from December to May, partly because the rain washes away the scant pollen in the flowers and together with the damp foggy nights is all too favorable for the development of the anthracnose fungus, *Colletotrichum gloeosporioides*, which then attacks the flowers.

An annual precipitation of 1,250 to 2,500 millimeters, falling mainly from June to the end of October in the northern hemisphere, is ample for the mango, and where irrigation is available it will succeed with still less rainfall. Here again, some varieties and races are probably more tolerant of rains during the blossoming season than others.

In the Philippines the climate is favorable for mango production at the lower elevations in Cavite, Batangas, Rizal, Bulacan, Pampanga, Tarlac, Bataan, Zambales, Pangasinan, La Union, Ilocos and parts of Laguna in Luzon Island, and in localities in Cebu, Bohol, Mindoro, Palawan and Panay where the precipitation is light from December to May. The higher elevations of all these districts are less adapted to the mango especially because of more rain, fogs and heavy dews.

The following table adapted from *Annual Amount and Distribution of Rainfall in the Philippines*, by Rev. M. Saderra Masó, Assistant Director, Weather Bureau, Manila, shows the rainfall where the mango is successfully grown in the Philippines:

TABLE I.—Mean monthly and annual precipitation in mango districts, Philippines.

Month	Manila	Cebu	San Isidro, Nueva Ecija	Balanga, Bataan
	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>
January.....	24	93.3	17.6	18.2
February.....	11.9	76.7	4.2	7.3
March.....	17.1	47.2	8.2	7.0
April.....	50.2	38.8	44.6	51.6
May.....	128.5	87.5	182.3	248.6
June.....	198.8	167.6	208.6	292.4
July.....	459.4	185.1	370.1	596.1
August.....	347.1	136.1	289.8	484.2
September.....	326.2	179.8	321.4	404.5
October.....	162.7	219.4	196.3	233.4
November.....	100.0	162.2	84.2	65.9
December.....	65.3	149.0	39.2	38.2
Total.....	1,886.2	1,542.7	1,766.5	2,442.4

In humid districts where there is an abundance of rain falling in all months of the year the Bauno, *Mangifera caesia*, Huani, *odorata*, and Bachang, *M. foetida*, will produce abundant crops, but the fruits, of course, are not equal to the mango in quality.

SOIL

The mango is adapted to a wide range of soils. In fact, the tree thrives on heavy clay as well as on poor, sandy and gravelly soil, provided that it is fairly deep and well drained. The mango requires abundant space for the development of its root system, however, and the tree is never long-lived nor does it grow well in a shallow soil. On rich lands the tree grows to a very large size with a heavy top at the expense of fruit production. Poor to moderately rich lands with a rather loose and even stony soil, at least 75 centimeters deep are best adapted to the mango. Occasional inundations do not injure the tree, provided the land has sufficient slope for drainage so that the water does not remain stagnant over a long period.

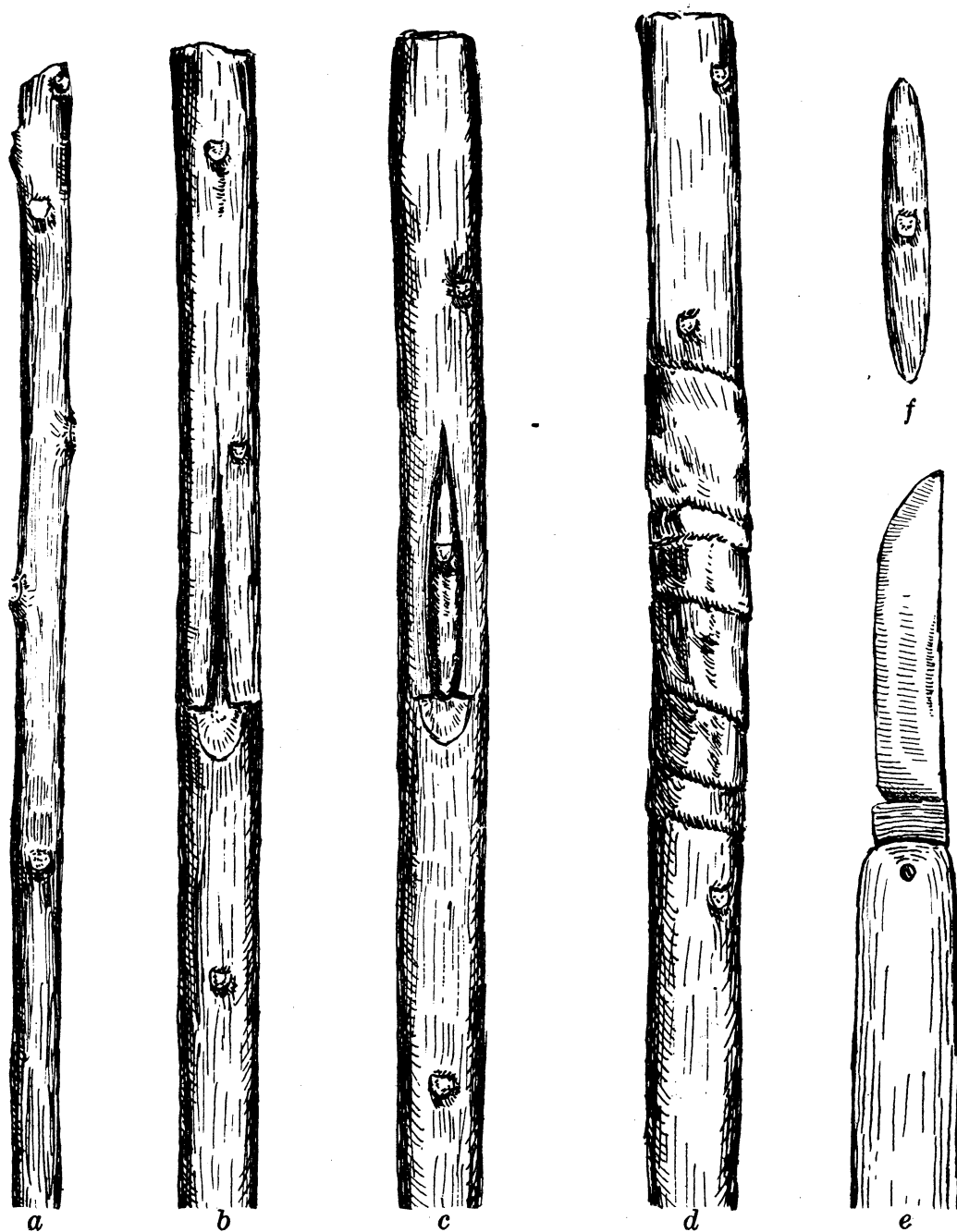
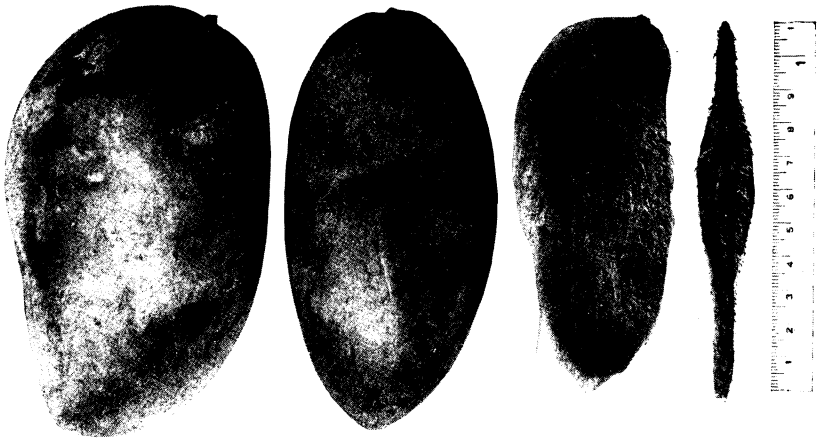


FIG. 1. Shield budding of the mango in progressive stages: (a) Scion, (b) section of stock prepared for insertion of the bud, (c) bud inserted, (d) bud tied, (e) shield bud, (f) budding knife.



(a) The Carabao mango, fruit and seed



(b) The Pico mango, fruit and seed

PROPAGATION

PRELIMINARY REMARKS

Considering that the problem of grafting the mango has just been mastered and that as yet there is no organized mango industry in the proper sense anywhere, it is only natural that the question of stocks should have been neglected. Yet, in the light of the information we possess relative to this matter in connection with the grape, the citrus and other fruits, there is every reason to believe that some species and varieties would be much more desirable than others as stocks.

Aside from the usual considerations a good mango stock should exert a dwarfing influence on the scion. At least this quality should be looked for in searching for a stock for the Philippine mangos, which are all too prone to grow into excessively large trees, difficult to handle in line with modern thought in orchard management. Plate XVa shows what might be accomplished in curbing the exuberant growth of mangos by the use of certain stocks. The top here is the Huani, which in September, 1912, was shield-budded on the mango. The plate was made from a photograph taken in May, 1920. The tree has from the beginning continued to make a healthy growth but has remained dwarfed and compact. The tree has been slow in coming into bearing; blossoming and fruiting for the first time in 1918.

For the convenience of those who may wish to experiment with various species of *Mangifera* as stocks for the mango a list of the species of this genus with the names of the lands in which they grow will be found on page 12.

THE REARING OF STOCK PLANTS

Healthy, vigorous stock plants are the foundation of thrifty productive trees. A remunerative orchard cannot be developed by planting weak, sickly trees. For this reason the seeds should be carefully selected from healthy, vigorous trees, and all small and poorly developed seeds, and seeds from windfalls should be rejected. In procuring seed for stock 15 to 25 per cent should be allowed for faulty germination. Unless it is kept moist, the mango seed loses its germinating power within a comparatively short time and should, therefore, be planted as early as possible after the fruit is ripe. Under no circumstances should the seeds be allowed to dry out.

If small lots of seeds are handled it is best to plant them from time to time as the fruits are eaten. If large quantities are used it is advisable to pile the ripe mangos *in the shade* to a depth of not more than 20 centimeters and allow the pulp to decay, and then wash it off the seeds before they are planted. If quick germination is desired the husk should be removed, but the gain in time is so light that ordinarily this does not pay considering the time consumed in husking.

The soil most suitable for propagation purposes is a sandy loam rich in humus. The seed should be planted in a well drained seed bed—under a slat-shed giving half shade—that has been prepared by grubbing the soil thoroughly to a depth of about 30 centimeters, removing carefully all stones and trash, and adding some well-rotted cattle manure or some commercial fertilizer well pulverized and thoroughly mixed with the soil. The seeds should be planted about 10 centimeters apart each way, laid flat on the ground and covered from 10 to 15 millimeters deep with soil. If planted deeper than that germination will be poor and few plants will be obtained. Then, the seed bed should subsequently be covered with a thin layer of chopped straw or weeds to prevent the soil from being washed away by the heavy rains that usually fall during the summer months after the seeds have been planted. As a rule watering is not necessary but this should not be neglected during long, dry spells if the soil dries out.

When the second or third flush of the young plants have matured—i. e., when the leaves are dark green and leathery—they should be set out in the nursery about 30 to 35 centimeters apart, in rows 120 or more centimeters apart to admit of convenient care of the plants afterwards. This work should preferably be performed on a cloudy day. About three-fourths of the leaves should be trimmed off and the end of the tap-root cut off to encourage the development of a better lateral root system.

The seed may also be planted direct in the nursery rows if the land is in good tilth and free of weeds. The seed should then be planted about 10 centimeters apart to allow for poor seed, and where they crowd each other the young plants should be thinned and reset in other rows.

It is a good plan to mulch the newly set plants in the nursery with straw or weeds to protect the soil from drying out. Then the nursery should be weeded and cultivated from time to time as needed.

If it is desired to inarch the seedlings, these should be transplanted from the seedbed to boxes, bamboo-tubes or pots when they have made two or three flushes, and they should be set near the edge of the receptacle in order to facilitate the inarching, as this operation can then be performed much easier than if the plants grow in the center of the box (Plate XIIa). If desired the seed may be planted direct in the receptacle, by which procedure the transplanting is avoided, though in the long run this is more expensive than to sow seed in a seed bed and transplant the seedlings.

Plants in receptacles should be grown in a plant shed admitting about one-half of the light. Such a shed is easily and cheaply constructed of bamboo.

Young mango plants in pots are intolerant of excessive moisture about the roots, and plenty of drainage material in the form of gravel or potsherds should be placed in the bottom of the receptacle at the time of transplanting, which, of course, should be provided with a drainage vent for the escape of water.

At all times when plants are transplanted the seedbed should be thoroughly watered, and great care should be exercised that the roots do not dry out during the transfer. After the plants have been set out they should be thoroughly watered.

If plants in receptacles are to remain in a healthy condition the soil in them should not be kept wet and soggy by repeated excessive waterings. The soil should be allowed to dry out until the plant is at the point of wilting before the next watering is made. Every few weeks the receptacles should be examined and all roots which are growing through the drainage vents should be cut off.

Plants in pots or boxes soon exhaust the supply of plant food, and it is therefore necessary to renew the fertility by artificial means. Where cattle manure is available, this should be strained through a sieve or coarse cloth (bagging) with water into a barrel and diluted until it is of the color of weak coffee, and the plants be watered with the manure water once in two or three weeks as their appearance may indicate, as much of the liquid being applied to a plant as the soil in the pot can absorb. Frequently manure cannot be obtained, however, and resort then must be had to artificial fertilizer. Where this is necessary, only the most soluble chemicals should be used, in order to get a good solution of a quick-acting fertilizer. The writer has for many years used the following formula for all

kinds of tropical plants, including mangos (applied as directed for the manure water), with excellent results:

Nitrate of soda.....	grams....	275
High grade sulphate of potash, 50 per cent.....	do....	125
High grade acid phosphate, 16 per cent.....	do....	350
Water	liters....	100

Superphosphate and other grades of sulphate of potash may be used but, of course, in proportion to their actual fertilizer content.

Care should be taken to see that all the constituents are well dissolved. The acid phosphate has a tendency to settle, and the solution should, therefore, be stirred up now and then as the watering proceeds.

The foregoing methods of growing mango stocks are specially applicable in a commercial nursery, and may be followed by the planter who grows his own stock.

Another method that may be used to advantage and which has much to recommend it is to rear the stocks in bamboo tubes as already described for inarching, and then set them out in the orchard at the beginning of the rainy season when they are about 9 or 10 months old. These plants will rapidly establish themselves in the field, and will be ready for topworking the following dry season or thereafter whenever convenient. To the planter who is familiar with shield-budding and has scions available for the work, this method of bringing an orchard into bearing is cheaper and easier than any other.

The transplanting of budded trees from the nursery to the field can be done, and even quite large mango trees can be safely transplanted, but the cost is so great that where economy is considered it is impracticable and inadvisable in the face of the slight cost at which young plants in bamboo tubes can be set out.

GRAFTAGE

PRELIMINARY REMARKS

The Philippine mangos are of such good quality and so closely reproduce themselves from seed that no effort has been made to propagate them by graftage in this country. Yet, this practice is accompanied by so many advantages that as compared with grafted trees seedling trees do not pay—if for no other reason than that so many are poor croppers. The planting of seedling orchards of the monoembryonic Indian varieties is in addition inadvisable because of their well-known variability.



(a) The Binoboy mango, fruit and seed



(b) The Señora mango, fruit and seed

The advantages derived from grafting the mango may be thus summarized:

(1) The productiveness of the tree and the quality of the fruit is assured.

(2) The season of maturity is to a large extent under control.

(3) The grafted trees come into bearing earlier than seedlings.

(4) The grafted trees do not grow so large as the seedling mangos, therefore;

(a) The trees are less liable to injury from typhoons,

(b) The fruit is more easily gathered,

(c) The control and eradication of mango pests are more easily effected in dwarf than in tall trees and,

(d) By shading the ground better the dwarf trees more than the tall ones assist in conserving the moisture of the land during the dry season.

It goes without saying that all scions should be taken from trees of desirable traits, for the budded trees will have the same traits and will bear fruits similar to those grown on the tree from which the scions were taken.

Foreign varieties of mangos of superior merit are or should be imported, but their desirability in their old home is no guaranty that they will be profitable in their new environment, and their planting should be confined to a few trees until their worth has been proven. On the other hand local seedlings of established value may be safely propagated in the expectation that the grafted trees will be equally good.

In order to merit propagation and culture a seedling tree or a variety must possess three or more of the following qualifications:

The tree should be:

(1) Productive

(2) A regular bearer; meaning that it should bear annually, or at least two out of three years

(3) Precocious, or coming into fruiting within a reasonable number of years after grafting, in the third to fourth year

(4) Of desirable growth and habit, i. e., the growth should be healthy and of good vigor, with preferably an open, spreading top

(5) Resistant to anthracnose and fruit flies

(6) Hardiness or resistance to cold, is a trait of especial value in sub-tropical countries subject to occasional frosts

The fruit should be:

(1) Attractive in form and color

(2) Of suitable size, from 350 to 1,000 grams in weight, with a minimum of 225 grams

(3) Of good eating quality and flavor, including a reasonable freedom from the fiber, and having a small seed

(4) Of good keeping quality and a good shipper

(5) Resistant to anthracnose and fruit flies.

To be at all worthy of propagation a tree must be reasonably productive, and be a fairly regular bearer of fruit of good quality. The value of a variety is enhanced corresponding to the degree with which these traits and the other qualifications are accentuated.

After many experiments with many methods of graftage the author has found shield budding the simplest and most satisfactory for the mango especially in the orchard and in top working. Inarching is also fairly satisfactory but it is more expensive and cumbersome and can be employed only where comparatively few plants are propagated.

The various methods of grafting the mango described in different publications from time to time have not stood the test of time, inarching and crown grafting excepted. At any rate they have not won acceptance and come into general use. Crown grafting first described by Woodrow some 20 years ago was likewise quickly forgotten but it has recently come into use in Porto Rico under the name bark grafting. Cleft grafting has been experimented with during the past year at the Singalong and Lamao experiment stations and found fairly successful.

The progress made in the art of grafting the mango was covered in detail in the former edition of this bulletin and need not be repeated here. Suffice it to say that the greatest single advance was unquestionably the discovery in 1909 by the late Orange Pound in Cocoanut Grove, Florida, of the practicability of shield budding, by the use of well-matured but green and smooth scions with long leaf stalks inserted in the stock of the same age and appearance, the buds being protected from sun-exposure by an apron. In the course of subsequent experiments at Lamao the author has since found that the apron is not necessary if the leaf blades of the scions are cut off sufficiently in advance of the budding to allow the formation of a well-healed leaf-scar before the buds were inserted. This discovery has further simplified the art of shield budding the mango, and this is now accomplished with the same ease as the budding of citrus trees. The method is, however, not so applicable to plants in the nursery as it is in working over trees 18 months or more old set out in the orchard, for the reason that the plants in the nursery do not develop sufficient diameter on the "buddable" part of the

stem sufficiently near the ground to make well balanced, small salable plants of convenient size for handling by the nursery trade.

As finally developed shield budding is the simplest and easiest method of grafting the mango in practice at present. In employing this method there is no need to consider the state of growth of either stock or scion at the time of budding. Aside from the ordinary precautions taken in all budding work, the only conditions are that *the scion should be well matured, green and smooth, the leaf scars well healed, and the buds inserted in the stock at a point also green and smooth like the scion.* A description of the procedure follows:

SHIELD BUDDING

Shield-budding of the mango may be performed at any time of the year provided that the stock plants are in good condition and the sap is flowing freely so that the bark is easily separated from the wood, and the bud is easily inserted. The dry season is, however, to be preferred for the work.

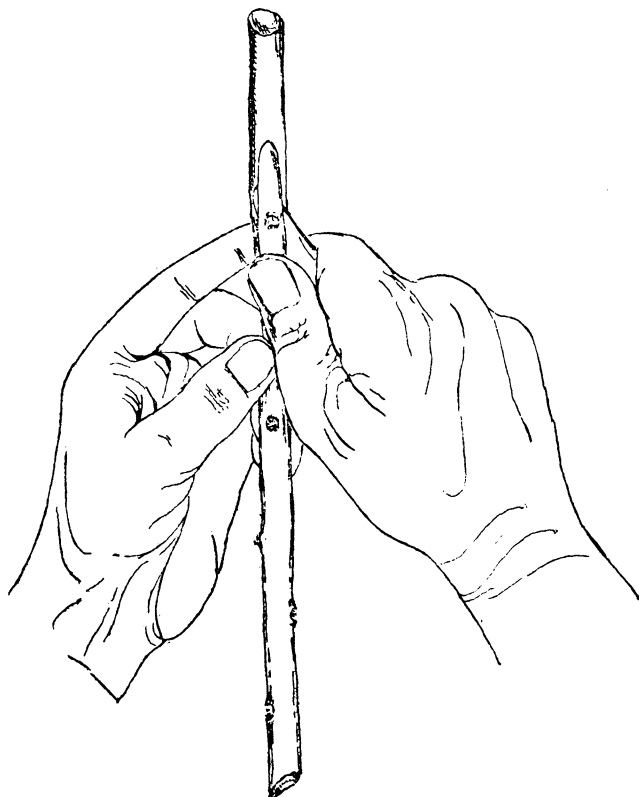


FIG. 2. The proper way of cutting a shield bud

It is essential that two to three weeks in advance of the date when the actual budding is to be performed the leaves should be cut off from the scions while *they are still attached to the parent tree* so that the petioles may drop and leave a well-healed leaf-scar. The scion should be well matured but green and smooth—with the buds well apart so that large buds can be cut—taken from the first, second and third flush of a branch.

The bud should be inserted in the stock at a point *where the bark is green and smooth*. It will not do to insert it where the bark is rough and brownish. The stems of young plants near the ground very rapidly become rough and brown before their diameter is sufficiently big to permit budding. For this reason the buds ordinarily cannot be inserted in the stock much below 50 centimeters above the ground. The stock should be from 15 to 20 millimeters thick at the point of insertion of the bud. Inverted T-budding is preferable, or pushing the bud up instead of downwards. To facilitate the insertion of the bud it is well to trim off the lower edge of the horizontal cut as shown in fig. 1. The buds should be cut large, with an ample wood-shield, not less than 40 to 45 millimeters long. After insertion the bud should be tied with waxed tape,^a firmly but without strangling the bud, as shown in fig. 1, so that the entire bud is covered.

As soon as the buds have made a good union, say from two to three weeks after the insertion of the bud, the tape should be unwound to the leaf scar so that the bud from which the growth is to issue is exposed, leaving the lower part of the bud shield still wound and covered by the tape. If the tape is re-

^a The best material for waxed tape for use in the tropics is cheap cotton cloth that tears easily. The wax with which the cloth is saturated is made from equal parts, by weight, of beeswax and resin. The cloth is prepared as follows: Tear the cloth into strips 15 to 20 centimeters wide, and wind the strips of cloth tightly on stout iron wire, or upon sticks, until the roll is not more than 5 centimeters in diameter. If the rolls are of greater diameter, the wax penetrates with difficulty to the innermost layers of cloth. In order to prevent the cloth from unwinding, tie a string around each end of the rolls. If the cloth is wound upon wire, the weight of the wire will sink the rolls in the mixture; if upon wood, the roll should be kept submerged until the cloth is saturated with wax. Place the ingredients in an iron pot and melt over a slow fire. Put the rolls of cloth in the melted wax for about 15 minutes. Do not permit the mixture to boil, or the cloth may be burned. When ready to use, unroll the cloth and tear it into strips about 2 centimeters wide (fig. 3). Cooled, the above mixture makes a good grafting wax.

Liquid wax is made by melting one kilogram of grafting wax and adding thereto 0.75 liter of alcohol; mix thoroughly, and keep in a tightly corked bottle.



(a) The Pahutan mango, fruit and seed



(b) The Bauno, *Mangifera caesia*, longitudinal section and seed

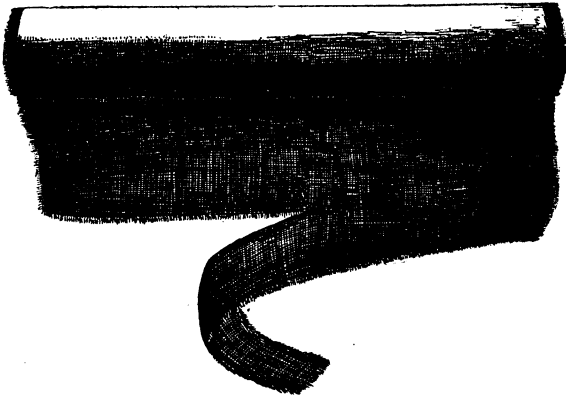


FIG. 3. A roll of grafting tape.

moved entirely the bark lips covering the bud curve outward and dry up, and the bud dies. At the same time the stock should be cut off 10 to 15 centimeters above the bud. Ordinary lopping will not answer, as the sap pressure is then too weak to force the bud into growth. Subsequently the wild sprouts of the stock should be carefully rubbed off every 10 days to 2 weeks until the bud has made a good start. When the bud has made a growth 15 to 25 centimeters long, the stock should be cut off just above the bud, and the wound carefully painted with white lead to protect it from the entrance of fungi and borers.

If the above directions are carefully observed and followed, an operator who successfully buds citrus fruits should have no difficulty whatever in getting at least 85 per cent of the budded mango plants to grow into healthy trees.

CROWN GRAFTING

Crown grafting was recommended by Woodrow⁹ over 20 years ago, but the essentials of the procedure apparently were beyond the grasp of the mango growers, for the method does not seem to have gained any headway, so far as can be learned from available current literature—except recently in Porto Rico and Hawaii under the name “bark grafting.”

In Porto Rico it has been used successfully at the Federal Agricultural Experiment Station in grafting young plants in the nursery and also applied to the top-working of old trees.¹⁰ Higgins¹¹ likewise reports success with this system from Hawaii.

In its modified form as applied in Porto Rico, Kinman enclosed the graft in a waterproof covering of paper, to prevent

⁹ Woodrow, G. M., Gardening in India, 1899.

¹⁰ Kinman, C. F., The Mango in Porto Rico, Porto Rico Agricultural Experiment Station, Bul. No. 24, 1918, pp. 10–12.

¹¹ Annual Report Hawaii Agricultural Experiment Station, 1916, p. 22.

the escape of moisture, in place of the "graft protector" of clay used by Woodrow. This makes practicable the employment also of the same method in top-working old trees.

When the seedlings are one centimeter or more in diameter and are in active growth—making a flush—they are in condition for grafting. Scions should be selected from well matured but green branches, the buds of which are swelling and about to

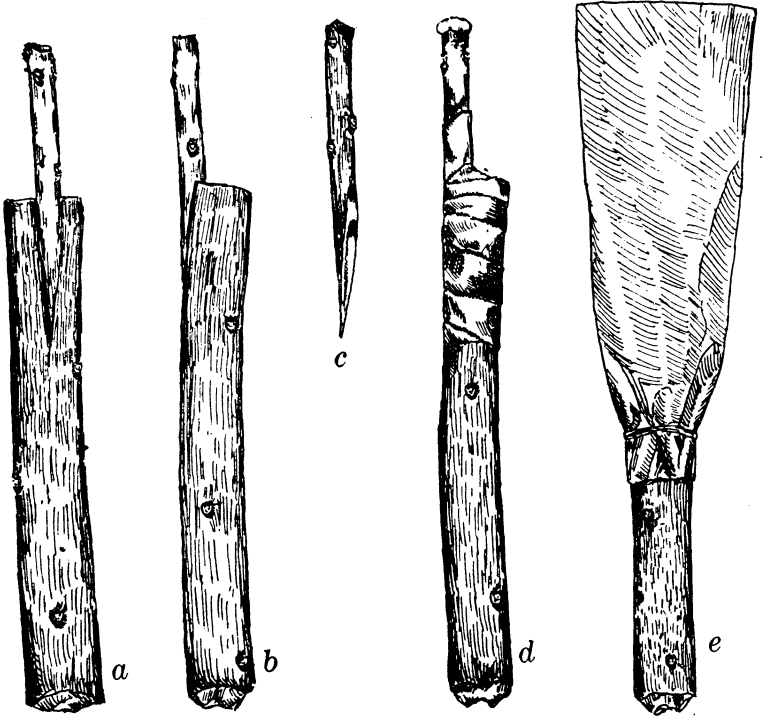


FIG. 4. Crown grafting of the mango: (a) Scion inserted in stock as seen from the front, (b) scion inserted in stock as seen from the side, (c) scion ready for insertion, (d) scion inserted, tied and waxed, (e) water proof paper bag covering scion to prevent evaporation.

make a growth. The stock is cut off about 10 centimeters or so above the ground, and a perpendicular slit 3 to 4 centimeters long is made in the bark with the knife, and the edges of the bark lifted as preparatory to inserting a shield bud. Next, the base of the scion, which should be from 7.5 to 10 centimeters long, should be cut wedge shaped by a slanting cut on one side as shown in fig. 4c and inserted into the slit, so that the plane surface of the cut faces the wood of the stock, after which the graft should be firmly tied with strong, soft cotton twine or waxed tape. The grafted plant is finally covered with a water-proofed paper and a string tied around it below the union to hold it in place as shown in fig. 4e.

As already stated, in Porto Rico and Hawaii, the method has been found applicable to the top working of old trees, the tops of which are first reduced as directed under top working.

As soon as the scions begin to make a growth the paper bags should be removed, as should also the binding if it strangles.

Waxing the wound and cut surfaces of the graft has not been employed in Porto Rico but its use would probably insure a greater percentage of live grafts. From 50 to 75 per cent successful grafts are said to be obtainable in using this method of grafting.

CLEFT GRAFTING

Sufficiently encouraging results have been attained in the cleft grafting trials made at the experiment stations in Singalong and Lamao during the past year to justify the belief that this method of grafting the mango will be practical enough for general use. It is of especial value because the grafting can be performed on small young plants which can be easily transplanted into boxes and established for long distance shipment.

In order that the graft may be successful it is essential that the scions be of the same character, and be prepared in the same way as already described under shield budding. In other words, the scion should be mature but must be green and smooth, and the leaves must have been shed and well healed leaf scars must have been formed before the scions are detached from the parent tree.

The scions taken from the tree should be cut into lengths of six to eight centimeters and then trimmed wedge shape and inserted into the stock, which should be cut off and split sufficiently high above the ground so that at this point the bark is green and smooth like the scion. If the stock is cut off so far down on the stem that it is brown and rough where the scion is to be inserted the graft will not succeed. After the graft has been tied and all cut surfaces waxed as ordinarily done in cleft grafting, a paper cylinder should be placed about the graft and tied as shown in fig. 5, and a handful of damp sphagnum moss placed within the paper around the scion to keep it from drying out until the union has been made.

When the union has been made, and the buds on the scion begin to swell, the paper and moss may be removed.

INARCHING

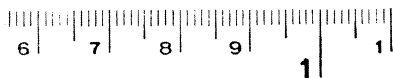
When the plants have attained the diameter of a lead pencil they are ready for inarching. On account of the heavy winds that are more or less a frequent occurrence in the Tropics, the trees from which the inarches are to be taken should preferably

have a stout fence built around them, made of wooden strips 2.5 by 7.5 centimeters or of bamboo, with openings 5 centimeters wide between the strips, to break the force of the wind. If the tree is not too large the enclosure of this skeleton fence may be roofed with the same material or with lath so as to admit half light. As there is then less evaporation, this will also lessen the need of water by the stock plants in the pots or boxes while the union is being formed, and the shade will prevent the burning of the roots in the pots by exposure to the sun.

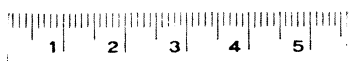
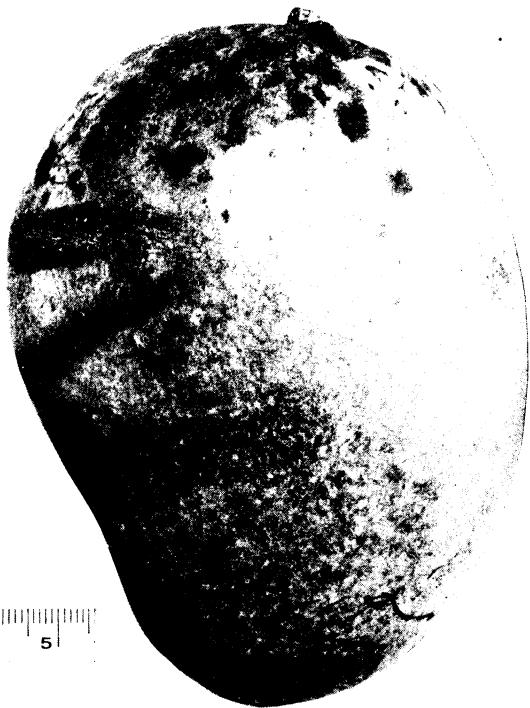
Before the inarches are put on it is necessary to erect a stout scaffolding around the tree, of a size according to the number of inarches to be made. If the tree is in the open, particular care should be taken to have the scaffolding well braced to prevent its being swayed by the wind, and to have the inarched branches firmly tied to the scaffolding.

The work is performed by removing the bark of the seedling with one cut by a sharp knife so as to expose the cambium layer for about 7 centimeters as near the roots of the stock as practicable, and then performing the same operation about 7.5 to 10 centimeters from the terminal bud of a twig on the tree from which the inarch is to be taken, selecting a twig of as nearly as possible the same diameter as the stock, so that when the two cut surfaces are pressed together they will make a snug fit. The stock and the scion should be firmly tied together, but not tight enough to strangle, preferably with grafting tape covering the whole length of the cut. Lacking grafting tape, soft cotton twine saturated with grafting wax will answer. Unwaxed twine is undesirable for it shrinks from the effect of dew or rain, constricting and strangling the young plant and preventing the free flow of sap. The pot should be firmly affixed to the staging to prevent any dislocation of the cut surfaces by heavy winds. And if the tree from which the inarches are made grows in the open, a piece of sacking or burlap should be tied around and over the pots to keep the roots from drying up from their exposure to the sun and wind until the union has been made, which in the summer, when the growth is more rapid, will be in from four to six weeks. Later in the year it will take longer. Watering should be carefully and regularly attended to, for if this is neglected more time is required before the union is effected; and furthermore, such neglect weakens the plant so that it can not so rapidly establish itself after it is planted out in the field as if it had been handled rationally.

About three weeks after the inarch is made a notch should be made in the stock just above the union, and another im-



(a) The Amini mango



(b) The Cambodiana mango

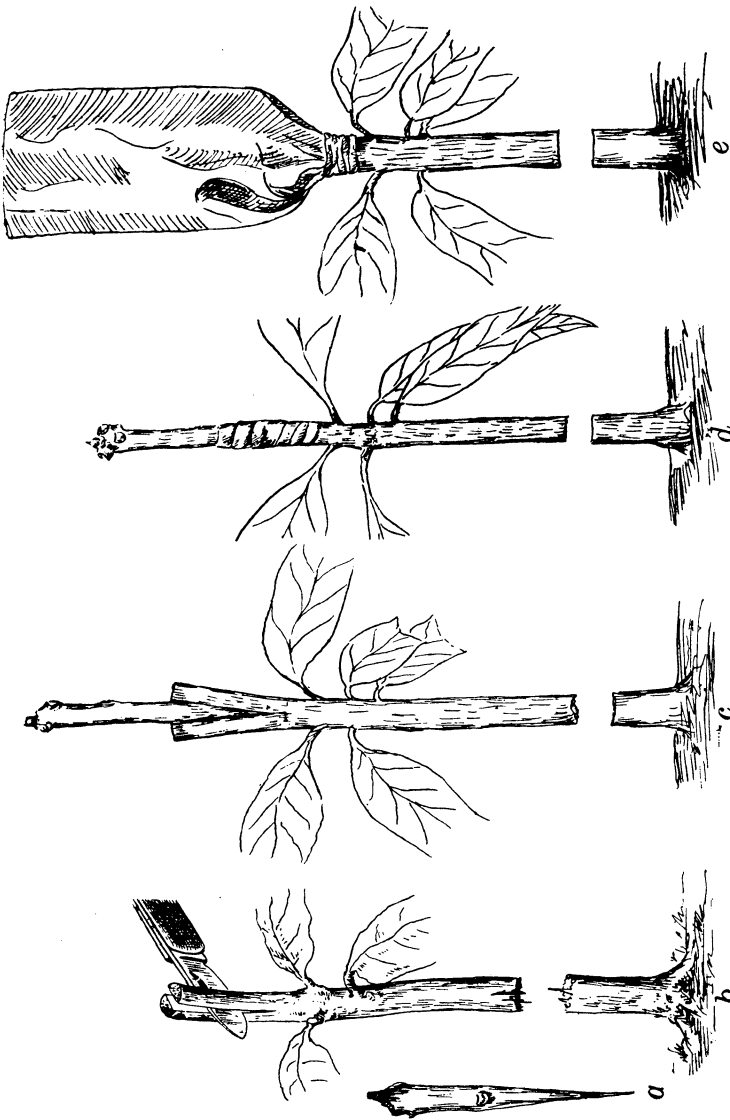


FIG. 5. Cleft grafting of the mango in progressive stages: (a) Scion prepared for insertion, (b) stock plant prepared for insertion, (c) scion inserted and tied (e) paper cylinder containing moist moss around the scion.

mediately below in the scion; after a week the lower notch should be made a little deeper and the top removed; in another week the lower notch should be made still deeper; and six weeks after the inarching was performed the plant can usually be completely severed from the tree. If an inarch can be made with a scion from a young shoot that is just ripening up, before the wood has become hard and rigid, the union is effected in much shorter time.

Should the union, for some reason, take place very slowly, the inarched twig may throw out one or two flushes or growths before it is detached from the parent tree, in which case it will be well to cut off the greater part of the foliage when the inarch is severed in order to prevent excessive evaporation, which would result in the drying up of the scion before good circulation of sap is established. The cut surfaces should be made smooth with a sharp knife, and the cuts painted with white lead, or covered with grafting wax to prevent the entrance of fungi. The plants should now be kept in a plant shed and carefully attended to for a few weeks, and allowed to make at least two or three good growths before they are planted out in the orchard. This extra trouble will be well repaid by the rapidity with which the plant establishes itself after planting.

In the experience of the author, wooden boxes made of thin boards, 12 centimeters wide, sawed off so as to make a box 30 centimeters deep with a board 12 centimeters square for the bottom, in which a hole 2.5 centimeters in diameter has been bored for drainage, have been found more satisfactory receptacles for mango plants than the ordinary flower pots usually employed. The plants thus having more soil in which to grow, develop more rapidly into stronger plants, do not become pot-bound, and establish themselves more quickly in the orchard than when the stock has been grown in pots. The size and weight of these boxes, however, are great disadvantages where the plants are to be shipped long distances. Large bamboo tubes may also be used for this purpose but they are less satisfactory.

TOPWORKING OLD TREES

The economic losses sustained by the grower because of unproductive seedling mango trees have already been pointed out on another page. How to remedy this evil is today the most pressing problem that confronts the mango grower. Yet the remedy is simple enough and merely consists in cutting down the old tops and working them over to better and more productive varieties. This is gradually being done with old seedling mango trees in Hawaii, Porto Rico, Florida and Cuba, and it can be equally well done in the Philippines.

If the trees are young shield buds can be inserted in the branches where they are green and smooth, and all the work performed as already outlined under shield budding. Plate XIVb shows such a tree after the first flush of the inserted buds.

As shown in this plate several buds should be inserted in the top, which then is rapidly renewed by their growth as contrasted with the slow recovery of the top from one or two buds.

Where the trees are old and large, suitable "stock," so to say, must first be provided in which to insert the buds. This is accomplished by heading back the branches to from 30 to 60 centimeters from the trunk and leading branches. In doing so the branches which are to carry the new top should be cut, leaving a few weak ones to maintain the circulation of the tree until a new top has formed. In the course of a few months a number of sprouts will issue from the stumps, and as soon as these are large enough the most desirable ones should be budded and treated as already described. All unbudded sprouts should be pruned off smoothly. All wounds should always be well painted with white lead and linseed oil; if this is not available coal tar may be used as second choice. In cutting off large branches it is always well to have the cut slope a little so that rain and dew will not remain long on the exposed surface. So much paint or coal tar that it runs down the limb should never be applied.

As the buds increase in size, the original top should be removed gradually; care should be taken, however, not to prune too severely, as that may injure the tree permanently, or even kill it.

SHIPMENT OF MATERIAL FOR PROPAGATION

Seeds that are to be shipped long distances should be thoroughly washed free from the pulp and spread out on the floor to dry in the shade for one to three days. The seed should be packed in coconut fiber, sphagnum moss or sawdust from hardwood trees, free from resin, that contains just enough water to make it feel moist when it is taken in the hand and squeezed. The different kinds of packing material are preferable in the order named. In packing sufficient packing material should be used to keep each seed separate. Packed in coconut fiber or sphagnum moss the seeds may be shipped in bulk, but the sawdust, even in small boxes, has a tendency to heat and the seeds are consequently destroyed. Small lots of seeds may be packed in either of the substances mentioned above, in cigar boxes lined with waxed paper in order to prevent the escape of any moisture in transit, and mailed. Tin boxes are also excellent containers. Seeds thus shipped by the writer from the Philippines to Florida have arrived with a loss of only 20 per cent.

Scions or budwood for shipment should be selected from straight growths of well-matured wood somewhat larger in diameter than a lead pencil and from which all leaves have dropped and on which all leaf scars are well healed. The scions should be packed in either of the packing substances recommended for packing the seed, contain the same amount of moisture, and be wrapped in stout oiled or paraffin paper, around which sufficient corrugated paper to protect them from all injury in handling in the course of transit should be wrapped. As final covering a good grade of Manila paper should be used. If tin tubes are available the scions may be packed in these without using oiled paper.

CLEARING AND PLANTING

The land should be cleared of native brush and trees, all stumps should be pulled out and burned together with the brush and timber, and the land plowed and crossplowed before it is staked and planted. This method is preferable in setting out a mango orchard, but an orchard may also be started by clearing away the timber and largest growth from the ground, after which the land is staked and a circular area cleared around each stake where a tree is to be planted. As the trees increase in size, the circle in which they stand should be enlarged until ultimately the land is entirely cleared.

There is a great diversity of opinion as to the proper distance apart at which mango trees should be planted, some Indian writers recommending a distance of 6 meters between the trees, 277 trees to the hectare, while some say that only 30 trees to the hectare should be planted, the trees thus being 18 meters apart. Judging from the size attained by the more mature seedling mangos in the Philippines, a distance of 15 meters is not too great in this Archipelago. However, the grafted varieties vary considerably in vigor and habit and it is possible that the average distance for grafted trees will ultimately become somewhat less. Certainly no mango orchard should be planted out with less than 10 meters space between the trees, and a distance of 12 to 15 meters is preferable for the more vigorous varieties. Aside from varietal variation in vigor, the fertility of the land, prevalence of moisture in the soil, and the amount of precipitation, are factors that should be taken into consideration as influencing the development of the trees, when the distance is decided upon. It should be kept in mind as well that where it becomes necessary to combat insect enemies or diseases by fumigation or spraying, the trees should stand sufficiently far apart to permit the work to be executed conveniently. What-

ever distances are used the trees should be set out equidistant in straight rows.

It is well to dig the holes for the trees a few weeks in advance of the time of planting. The holes should be dug about 60 to 80 centimeters wide and 40 to 50 centimeters deep. In planting the trees the holes should be filled with surface soil—in place of the acid subsoil dug out of the holes—and this should be worked in carefully among the roots allowing them to remain in a natural position.

The mango should never be planted deeper than it stood in the nursery, for then it remains stunted and fails to make a good growth.



FIG. 6. Planting board.

The intelligent planter will have so arranged all preliminary work, including digging the holes, that the plants can be set out with the arrival of the first rains, for then the young plants will have the benefit of the entire rainy season in becoming established, and the cost of watering is reduced to a minimum.

Unless the planting is accompanied by a heavy rain, on being set out the plants should be well watered. Pot-grown plants should be closely watched and watered frequently until they are well established if the weather is dry. They are in this respect more particular than trees grown in a nursery, having all the roots matted together in a small ball of earth and not coming in contact with so much moisture as they would if the roots were spread out in the soil. Where the trees are planted out from large wooden boxes they establish themselves more rapidly, nevertheless, they require somewhat more attention with watering than nursery-grown trees. To prevent excessive evaporation until the trees have become established, it is well to prune away about two-thirds of the foliage and all tender growth at the time of transplanting. It is also of benefit to cut some leafy branches and stick them in the ground around the young plants for shade if the weather is hot. During dry weather, until the rains start in earnest, it is well to keep the trees heavily mulched.

If devoid of natural windbreaks, orchards are usually protected from high winds by the planting of robust, strong-growing trees less easily injured by storms than the fruit trees. The mango itself is, however, so admirably adapted for this purpose that to plant other non-fruiting trees with this end in view would be wasting space, for even if some fruit is lost through

the exposure to the wind in the outmost rows in the orchard more or less will always mature on the tree.

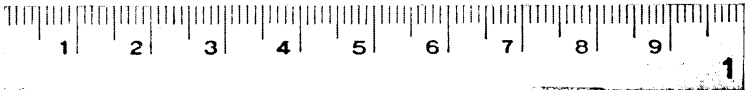
The long, dry, hot season in an ideal mango country is a severe ordeal for a young mango tree that was set out in the field only a few months ago. And, as a matter of fact, the first dry season of the trees in the field is the most critical time of the orchard. If the young trees come through in good shape until the rains again begin to fall they have made a long start towards becoming established. If they are left to themselves, many plants will perish from the effects of the long, dry season, or else make a very slow growth. The intelligent planter who expects to bring his trees into early bearing will, therefore, at the close of the rainy season hoe up all weeds in a wide circle around each tree, say two meters in diameter, and pile a heavy mulch of weeds and grass on this space so that the ground shall be protected from drying out. This will conserve the moisture to a surprising degree and keep the trees growing through most of the dry period. If, as the season advances, some trees appear to be suffering from want of water, a basin should be made around each and one or two buckets of water applied. If the mulch is replenished at the same time, this amount of water will keep the earth moist for a long time and the work prove an effort well spent.

TILLAGE, COVER AND SECONDARY CROPS

The wide spacing of the mango necessarily leaves much land vacant between the trees for a period of at least 4 to 5 years after planting. This space can to advantage be planted to annual crops, such as upland rice, corn, mungos, gabi, or other field crops. Small, quick-growing fruit trees such as the guanabano, *Annona muricata*; sugarapple, *A. squamosa*; custard-apple, *A. reticulata*; cherimoya, *A. cherimolia*; guava, *Psidium guajava*; carambola, *Averrhoa carambola*; bilimbi, *Averrhoa bilimbi*; iba, *Phyllanthus acidus*; orange, *Citrus sinensis*; mandarin, *C. nobilis*; lime, *C. aurantifolia*; and lemon, *C. limonia*; may be employed as secondary tree crops. These trees should be planted one in the center of each square, or as many in one hectare as there are mango trees, if these are set out 10 meters apart. If the mango trees are planted out at the maximum distances, one of the secondary trees should be planted between each two mango trees and one in the center of the square.

Bananas and papayas should be set out about 3 to 4 meters apart in the interspaces.

Corn, sweet potatoes, yams, sincamas, roselle, beans, and in fact, any vegetable or field crop to which the land is adapted may profitably be grown in the orchard as a secondary crop,



The Sandersha mango

provided that the cultivation is not carried so close to the trees that the work animals injure them or the cultivators tear or break their roots; in fact, it is beneficial in that the constant stirring of the soil aids in rendering plant food available to the plant that hitherto may not have been available.

The decided benefits derived from the use of cover crops to other fruit trees are of equal advantage to the mango. By adding humus the leaching of fertilizer, particularly nitrates, is prevented during excessive rainfall, the clay soils are rendered more friable and prevented from becoming too compact, the water-holding capacity of sandy soil is increased, and where leguminous cover crops are used, a considerable quantity of nitrogen is added to the soil. Therefore, whenever the land is not occupied by catch crops it should be planted to some leguminous cover crop. The seed of these should then be sown at the beginning of the rainy season, and the growth plowed in or piled around the trees for mulch when the dry period begins. Suitable cover crops are Lyon and Velvet beans, "New Era" or "Clay" cowpeas, Cadios, *Cajanus indicus*, or any local annual legume of rapid growth. The seed of these plants should be drilled in to admit of one or two cultivations to keep down the weeds until the plants have made a good start. Leaves and weeds should always be piled around the trees for mulch or else plowed in to enrich the land. They should never be burned.

The above applies to a young orchard. When the trees fill up the space and come into fruiting, clean culture is preferable, especially during the fruiting and harvesting season, for the gathering of the fruit cannot conveniently be attended to without injury to the annual crops. The land should then be plowed and harrowed at the close of the rainy season, which should be repeated when the early rains have softened the earth at the close of the dry period.

PRUNING

Pruning is a recognized, systematized cultural practice to increase fruit production employed by the fruit growers in the temperate zone. To what degree if any, production of mangos may be increased by pruning is largely conjectural as no experiments in pruning seem to have been conducted anywhere.

Young trees, especially of varieties of tall and upright habit should be headed back and induced to form low, spreading tops. Tendencies to irregularities in the top should be corrected, and dead and weak branches should be removed.

Some writers recommend root pruning to encourage fruiting, but if employed at all it should be used with caution, and only the small roots that heal rapidly cut off, or termites may gain en-

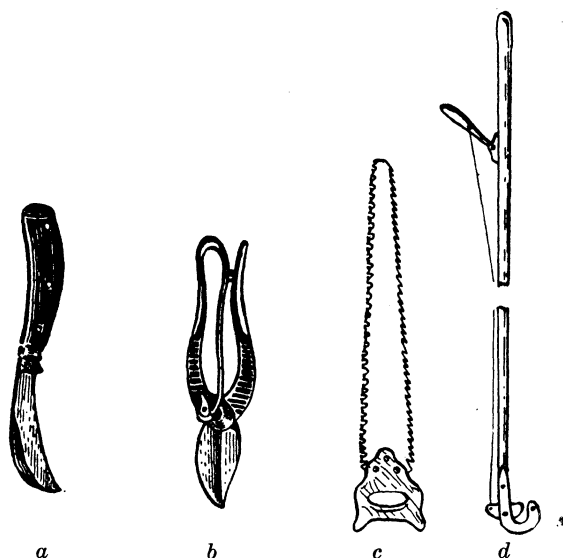


FIG. 7. Pruning tools: (a) Knife, (b) shears, (c) saw, and (d) tree pruner.

trance. Then, too, severe root pruning in a country where typhoons are prevalent is apt to be followed by the uprooting of the trees by strong winds.

All cuts of any considerable size should be carefully painted with coal tar or white lead to prevent the entrance of fungi, borers and termites, and all prunings should be removed and burned as otherwise they serve as a breeding ground for pests which subsequently may invade the mango trees.

FERTILIZATION

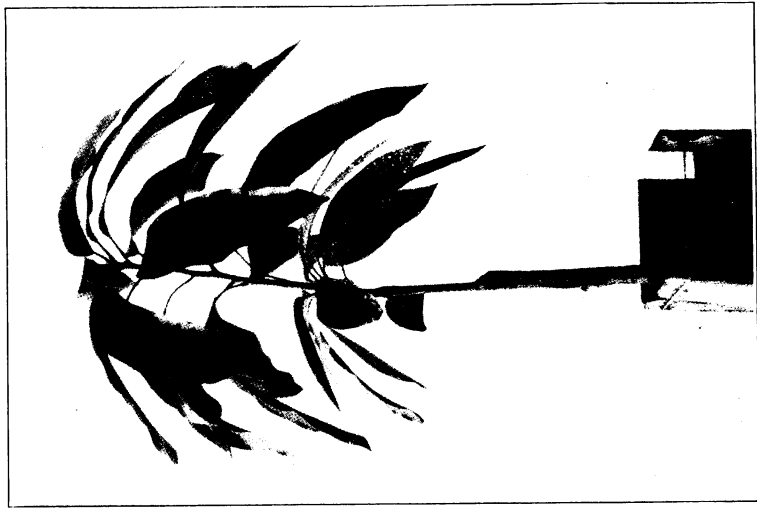
Cultivation of mangos as so understood by these words in the United States, cannot be said to exist in the Philippines, and no artificial fertilizers have been applied to the mango tree here. At present it is therefore impossible to give specific recommendations as to what amount to use, as well as which formula and what constituents, based on any experiences in the Philippines.

The soil in the Philippines is in general sufficiently rich in all elements for the development of the trees, in fact it is too well supplied with nitrogen, and the trees in consequence develop foliage at the expense of fruit production. During the early development of the trees, artificial fertilizer is ordinarily an unnecessary expenditure in this country, but later when the trees come of bearing age, to counteract the influence of a superabundance of nitrogen in the soil, it would therefore seem reasonable that the judicious applications of a fertilizer containing potash and phosphoric acid would increase fruit production.

Judging from the experience in Florida, a formula calling for



(a) Inarching



(b) Inarched plant ready for the field

8 per cent phosphoric acid and from 3 to 4 per cent potash is likely to answer. Such a fertilizer can to the best advantage be made from 450 kilos superphosphate (17 per cent) and from 60 to 80 kilos high grade sulphate of potash (50 per cent.) About two kilos of this mixture should be applied twice a year, coincident with the plowings at the beginning and close of the rainy season, to a tree with a crown diameter of 5 meters, larger trees receiving proportionately larger amounts. Or 400 kilos bone meal (20 per cent phosphoric acid, 5 per cent nitrogen) might be substituted for the superphosphate, which would also give the mixture 2 per cent nitrogen. The fertilizer should be broadcasted on the ground away from the trunk in a circle under and slightly outside the crown.

The application of well decomposed stable manure to the young trees will hasten their development, but when they become of fruiting age it is best to use it only on very poor soils.

FORCING

The forcing of vegetables, fruits and ornamentals is a common enough practice in the United States and Europe, where it is accomplished by the use of artificial heat applied in hothouses and hotbeds. So far as the author is aware the mango is the only plant which is forced to fruit out of season in the tropics, and the Philippines is apparently the only land where it is done. Speaking of various means of inducing mango trees to fruit, the following passage occurs in *A Treatise on Mango*, p. 104, by P. C. De. "Rai Setab Chand Nahar Bahadur of Azimgunge says that some time ago he had one of his mango bushes which had never borne fruits, treated by burning the grounds underneath it. The process was easy. Weeds were collected and strewn over the surface underneath the tree and fire was set. The fire of course, was not allowed to conflagrate, nor to injure the tree in any way." But if occasionally resorted to in India it is certainly not an established practice as in the Philippines, for no other Anglo-Indian writers mention the use of fire as a means of forcing the mango to fruit; and concluding De says: "I had no occasion to try it," showing that he did not take much interest in the method of which he speaks.

In the great mango district in Cavite, near Manila, especially, mango trees are annually forced into fruiting for the Manila market.

The firing is sometimes started as early as August, but is also done as late as December. It is sometimes done merely by burning brush on the ground beneath the mango trees, but where it is more "professionally" done, so to speak, a cone-shaped enclosure with a tall chimney ending in the top of the

tree is built of green wooden stakes and a thin-walled bamboo, woven together as shown in Plate XVII. The lower part of the enclosure is plastered with a mixture of mud and straw on the outside and the "oven" is ready for operation. Green brush and weeds are used for fuel with the idea of producing a thick smoke. The wiry growth found at the base of the spiny bamboo, *Bambusa spinosa* Roxb., is considered especially good fuel. Sometimes a small quantity of sulphur is put in the fire. At no time is the fire made so hot that the trees are injured.

After the firing of a tree has begun, the tree is "smoked" heavily and continuously day and night for a week. Thereafter light fires are made morning and evening for about a month, or until the trees come into bloom. As a rule the fires are then put out, but a light "smoking" is sometimes given the trees to drive away the mango hoppers, which are recognized to be destructive to the bloom.

Trees forced early in the season sometimes come into bloom before the rains are over and, failing to set because of excessive moisture, they are then subjected to a second firing.

It is claimed that mango trees can be forced to fruit any time of the year by the means of the method described, provided, of course, there is bright weather during the flowering, for rain invariably destroys the flowers.

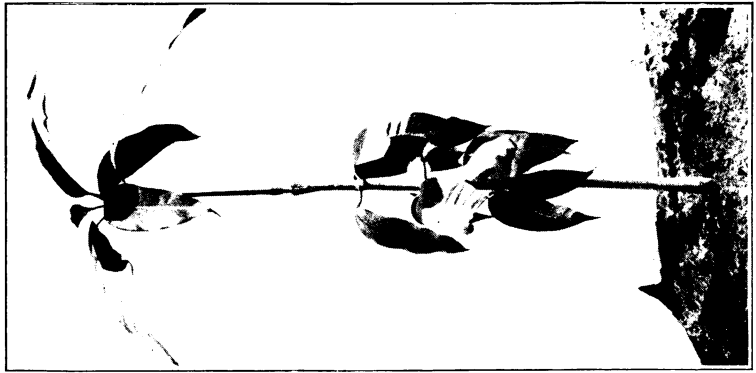
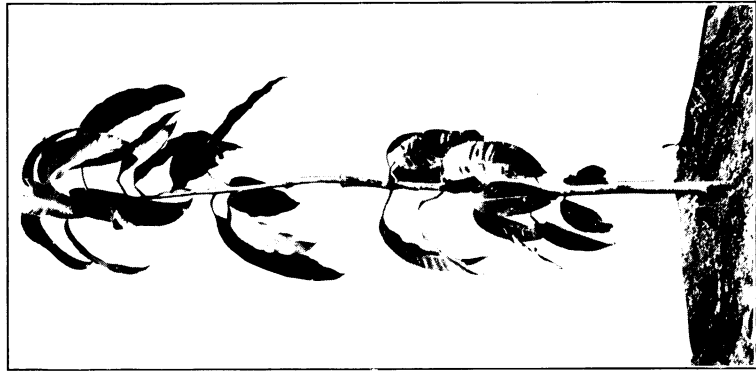
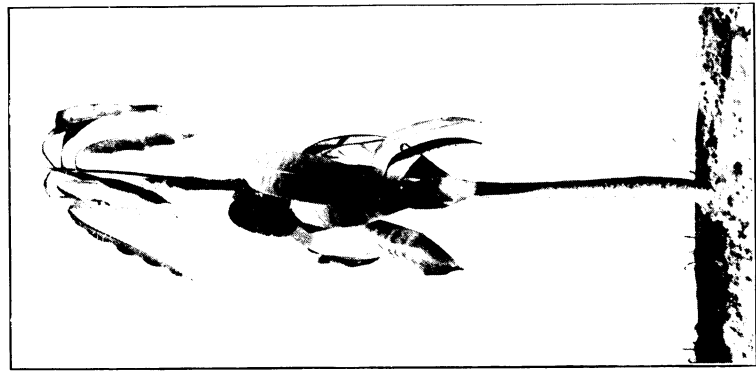
MARKETING

The marketing of the fruit is a problem of great importance, the failure or success of the production of the mango as a commercial undertaking depending largely on the successful solution of this problem.

Where the fruit is handled properly its shipping qualities are very good in many varieties, fruit shipped from the West Indies to England and France, and even from India to London, arriving in condition. The tomato crate is commonly used in Florida for shipping mangos, and seems to answer the purpose well. A ventilated crate, 30 by 30 by 60 centimeters, with a dividing board in the center, and 2 trays of a thin board to distribute the weight, would probably be found to be a suitable carrier in the Philippines.

Great care should be exercised in the handling of the fruit from the time it is picked until it is packed, in order to reduce the number of spoiled fruits to a minimum. Each fruit should be wrapped in soft tissue paper before it is put into the crate, and care should be taken to see that no fruits can move about after the crate is nailed up.

The Carabao and the Pico varieties in this country both have good keeping and shipping qualities, and considering their ex-



From left to right; one shield budded and two cleft grafted mango plants. Singalong Experiment Station, Manila

cellent eating quality, if the fruit was properly packed and handled, mangos could be exported in large quantities from the Philippines to the China Coast, Japan and Singapore, and even Java.

Canned mangos are excellent, and if the mango orchards were extended a mango canning industry of great proportions might well be developed, centralized in Manila and in Cebu.

COMPOSITION AND USES OF THE FRUIT

The following analyses of the Carabao, Pico and Pahutan mango are quoted from the Philippine Journal of Science:¹²

TABLE II.—*Analyses of Philippine mangos*

Variety	Fruit aver- age weight	Edible por- tion	Skin	Seed	Total solids	Inso- luble solids	Protein	Ash	Sugar as in- vert
	<i>grams</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
Carabao (ripe)	240	73	11	14	17.2	2.6	0.22	0.45	13.24
Carabao (green)	175	70	20	10	13.7	2.8	0.23	0.25	1.90
Pico (ripe)	230	73	12	15	23.6	2.8	0.75	0.40	18.40
Pahutan (ripe)	85	60	18	22	25.7	8.1	1.12	0.53	17.54

Except in the weight of the fruit and in the percentage of the edible portion, which vary to a considerable extent in the different races and varieties, the above analyses are fairly representative of the mangos grown in other parts of the world.

The mango in the Tropics takes the place of the apple in the Temperate Zone, but as an article of diet it is more valuable than the apple because its large sugar content has considerable food value.

The favor with which the mango is regarded in the Tropics may be taken as an indication of its coming popularity in the Temperate Zones when the better class of mangos are once introduced there.

In some parts of Spanish America where the seed is large and the flesh is fibrous, the mango is eaten with the aid of a three-pronged fork having one long central tine that penetrates the seed, and two shorter ones that prevent the seed from turning. The fruit of the fiberless varieties may be served in halves, or the skin may be cut transversely near the tip and also near the base. By making a longitudinal cut connecting the others, the skin is then easily peeled off. This leaves the flesh exposed and yet allows the fruit to be held in the hand without soiling the fingers.

Excellent mango sauce, very similar in flavor to that made from the apple, may be made from the full-grown, immature mango.

¹² Pratt, D. S. and Rosario, J. I. Philippine Fruits; Their Composition and Characteristics, Phil. Jour. Sci. VIII, No. 1, Sec. A, 1913, p. 76.

It is prepared by peeling the fruit, slicing the flesh, and boiling it together with a little water, adding sugar to taste.

The sauce strained through a thick cheese-cloth, and the juice diluted with water and sweetened makes an excellent mangoade. Excellent ice cream may be made from the mature mangos or the sauce from the immature mangos already referred to.

The following recipes for utilizing the fruit will also be found useful:

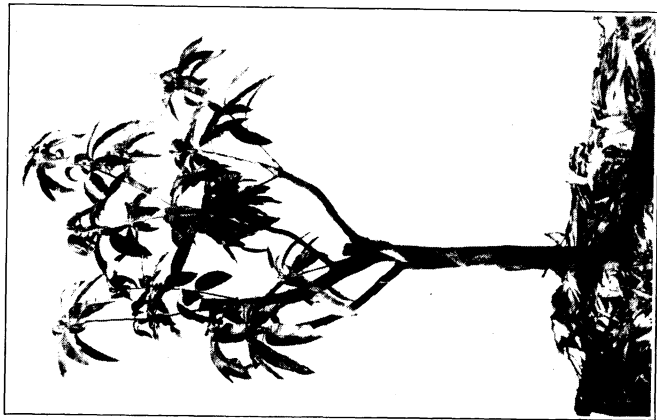
Jelly.—Peel the mango as it begins to turn yellow, before it softens; slice the pulp from the seed; pour enough water in the pan to cover the fruit, and boil until quite tender; strain through muslin cloth; to this juice add an equal quantity of sugar and boil till it jellies. Lime juice may be added if more acidity is desired in the jelly than is present in the mango.

Marmalade.—The pulp left after the juice has drained off in making jelly can be run through a fine sieve, boiled with an equal quantity of sugar and a little lime juice added to make it firm, until it thickens like cheese. (Marmalade, of course, can also be made direct from the fruit, i. e., with its own juice, retained.)

It has been stated that if the mango seed is boiled together with the preserve, this will retain the flavor of the fresh mango. The seed, of course, is thrown out when the preserve is put up in jars.

Mango preserves.—Select mangos just showing color; peel and slice; to each kilogram of fruit use 1 kilogram of best white sugar and 2 teacups of water; boil the sugar and water until it drops from the spoon very heavy, then pour over the fruit and let stand until cold. Pour off the sirup and boil down as before; when the sirup is quite thick, drop in the fruit and boil hard for twenty minutes. Seal at once.

Candied mangos.—Select mangos just showing color; peel and cut from the seed in large pieces; use 1 kilogram of sugar and 2 teacups of water for every kilogram of fruit; boil the sirup and pour over the fruit, letting it stand two or three hours; then put on the fire and bring all to a boil; let stand over night; next morning pour off sirup and cook till it threads; pour over fruit again and let stand till next day. Repeat this process every day for three days, by which time the fruit will have absorbed all the sugar it can take. On the fourth day drain off the sirup and cook till it threads, drop in the fruit and boil about five minutes, very hard; drain off all the sirup, using a porcelain colander; when the fruit is dry lay on plates in a hot, airy place, in the shade, until it is well dried and cover it with a thin cloth.



(a) A 3-year old mango seedling about 4 months after the top was cut back to induce the production of young growth suitable for shield budding. All superfluous young shoots have been removed and the remaining ones are ready for budding



(b) A topworked (shield-budded) young mango tree eight weeks after the insertion of the buds. Lamo Experiment Station

Chutney.¹³—Take 3 kilograms of pulp of the common mango (turned but not ripe), 3 kilograms tamarinds, 2 kilograms raisins (weighed after stoning), 8 kilograms brown sugar, 0.5 kilogram chilies, 2 kilograms green ginger, 0.5 kilogram garlic, or 1.5 kilograms onions, 0.25 kilogram mace, 65 grams mustard seed, 15 grams cloves, 15 grams pimento, 0.5 kilogram table salt. Soak the tamarinds in 4 liters of the best vinegar, stir them about with a wooden spoon to get the pulp off, and take out the seeds. Cut the raisins small. Peel the ginger and grate it. Pound the chilies, garlic and mustard seed in a mortar, using a little of the vinegar for moistening. Mix all together thoroughly with the mango pulp. It is then ready for use.

The mango is used as a pickle to some extent in the Philippines and it is similarly prepared in India. In that country, where the mango is an important staple of food, the fruit, immature and ripe,¹⁴ is utilized in many ways.

When green, the stone is extracted, the fruit cut into halves or slices, and (a) put into curries; (b) made into a pickle, with salt, mustard oil, chilies, and other ingredients; (c) made into preserves and jellies by being boiled and cooked in sirup; (d) boiled, strained, and with milk and sugar made into a custard known as "mango fool;" (e) dried and made into the native "ambchur," used for adding acidity to certain curries; (f) when very young cut into small pieces, mixed with a little salt, and sliced chilies and milk added, it forms a "tasty salad."

When ripe (a) it is made into curry which has a subacid, not unpleasant taste; (b) it is cut into small pieces and made into a salad with vinegar and chilies (the sour fruit is sometimes so used); (c) the juice is squeezed out, poured into plates, and allowed to dry; this forms the thin cakes known as "amb-sath." The kernels are eaten in times of famine, and by the poorer classes in many parts of India they are boiled and eaten as greens. They are also ground with meal and mixed with various other ingredients to form a relish known as "am-katai." When stuffed with coriander, turmeric, and other spices and boiled in mustard oil, they are esteemed a great delicacy.

OTHER USES OF THE MANGO

While the mango is not credited with having recognized medicinal properties, in India it is largely prescribed by the natives for many and varied diseases.

¹³ Bull. Bot. Dept. Jamaica, No. 46. (The figures have been converted into the metric system.)

¹⁴ Watt, G., Dictionary of Ec. Prod. of India, 1891, Vol. V, p. 155.

The bark and seed contain tannin, the former analyzing 16.7 per cent. In some parts of India the bark and leaves are used in the manufacture of dyes. An account is given by Collins¹⁵ of a method whereby coloring matter is indirectly obtained from the mango leaves, by feeding them to cows whose urine is collected and made into a dye.

The wood is fairly durable if not exposed to water, but is liable to be attacked by insects.

DISEASES

In the early seedling stage the mango is subject to damping off, *Sclerotium* sp. This fungus attacks the plant just above the ground when it is tender and brittle, before the first hardening of the tissues. Part of the stem becomes soft as if scalded, and the plant falls over and dies. The disease is invited by over-watering and lack of drainage, and is easily prevented by withholding water, allowing the seed bed to dry up. Dead plants should be removed from the seed bed and destroyed.

Mildew, *Oidium*, sp., is another very common disease of seedling mangos in Florida. This is also induced by weakening the plants by over-watering, but is easily overcome by dusting them with dry, powdered sulphur and allowing the soil to dry up. The mildew is recognized by the appearance of the underside of the leaf, which becomes covered by the flour-like sporangia, giving the leaf the appearance of having been sprinkled with fine white dust. The leaves subsequently curl up and become distorted.

Anthraxnose, *Collectotrichum gloeosporioides* Penz., is the most serious disease of the mango, attacking the leaves, flowers and fruit.

The damage to the leaves is insignificant, but the injury to the flowers, especially when rains fall during the blossoming season, or heavy fogs and dews settle on the trees during the night, is frequently so great as to sometimes cause a partial or even complete failure of the crop.

Spraying the flowers with Bordeaux mixture was found to control this trouble in South Florida for several years, but McMurran has later attempted to show that these successful applications were accidental, due to favorable weather conditions.¹⁶ As successful employed the spray was applied to the flowers as they first appeared, and was repeated once or twice before all were shed.

¹⁵ Collins, G. N., B. P. I., U. S. D. A., Bull. 28, 1903, p. 24.

¹⁶ McMurran, S. M. The Anthracnose of the Mango in Florida, U. S. D. A. Bul. No. 52, 1914.

The same fungus causes the fruit to become black-spotted and streaky, which detracts from its appearance, shipping and keeping qualities. To some extent this evil may also be controlled by judicious applications of Bordeaux mixture.

Some mango varieties are practically immune to at least anthracnose on the fruit, while others are very susceptible. This is a trait well worthy of note by prospective mango planters.

INSECT PESTS

PRELIMINARY REMARKS

The problem of insect control is a large factor in successful fruit culture. Wherever large orchards of a fruit are planted, the balance of nature is disturbed and an artificial condition is created. Insects that prove comparatively harmless under natural conditions, when the trees of one species are interspersed with those of another, making difficult their transmigration from tree to tree and their food supply scarce, may prove destructive and dangerous pests in an orchard where ideal conditions prevail for their multiplication, by reason of an abundant food supply and the ease of migration from tree to tree.

The study of the insects affecting the mango is a much neglected field, and a vast amount of work remains to be done by future entomologists. In proportion as our knowledge of their life-history increases we may expect to control, perhaps even to eradicate some of them.

If the insects assume the character of a pest in the mango orchard, measures must be taken for their control; failure to do this frequently means that the difference between profit and loss must be entered on the wrong side of the ledger. This may be done by spraying, or by jarring of the trees and gathering and burning the fallen insects (when the enemy is a beetle or caterpillar), or by the destruction of fallen, infested fruit.

A study of the life-history of an insect pest may reveal that it can be cheaply and effectively controlled by parasitic fungi or insects, or by predaceous insects; and the appearance of insect pests in the orchard should, therefore, be reported to the proper authorities.

The different parts of the mango tree are affected by a number of insects. So far, however, the majority of these have not been reported to seriously injure the plant perhaps because they in turn are, in many instances, themselves the prey of predaceous insect or fungus parasites which prevent their rapid multiplication.

The insect pests that hitherto have appeared to be of primary importance are those that attack the inflorescence, the fruit and

the seed of the mango. The scales and biting insects seem to have been less destructive; some injury is caused by borers.

THE MANGO HOPPER

The most serious pest of the mango is the mango hopper, the vernacular name for three species of homopterous insects, *Idiocerus atkinsoni* Leth., *I. clypealis* Leth., and *I. niveosparsus* Leth., which some years in certain parts of India are reported to have reduced the mango crop to one-third of its normal value. These insects, which are found on the mango throughout the year, do not occur as an annual pest, but appear in great numbers every few years at the flowering season, when the principal injury is inflicted. The insect is a small, dark, wedged-shaped "hopper," that jumps or flies short distances. The eggs are apparently laid on the tender flower panicles, where they hatch, and the larvae as well as the adults blight the bloom by sucking up the juices that should assist in the formation of the flowers and fruit. The two last mentioned of these species of this genus occur in the Philippines where some years they are very destructive. In the Philippines the presence of these insects is readily noted by the sooty mold which grows in their excretions on the foliage of the mango, which turns black on the upper side. When the insects are very abundant even the ground and herbs beneath the trees turn black from the same cause.

When they appear in great numbers, these insects spell crop failure of mangos for the current season.

Remedies.—The life history of the mango hopper has never been thoroughly studied and is not yet well known. A remedy cannot therefore with certainty be recommended. Experimental spraying with formulas 2, 3 and 4 of gradually increased concentration is recommended.

FRUIT FLIES

Fruit flies form the second most important pest of the mango, of which the mango fruit fly, *Chaetodacus ferrugineus* Fabr., the Mediterranean fruit fly, *Ceratitis capitata* Wied., the American fruit fly, *Anastrepha fraterculus* Wied., the Queensland fruit fly, *Bactrocera tryoni* Frogg., and the Mexican fruit fly, *Anastrepha ludens* Loew, are known as the most destructive.

The mango fruit fly has been found in India, Ceylon and Burma, Formosa, the Philippines, Java and Amboina, from which countries several sub-species have been described within the last few years, and it probably occurs throughout all parts of Malaysia.



(a) Huaní, *Mangifera odorata*, shield budded on the mango.
Lamoo Experiment Station



(b) A young topworked mango tree (sandersha) in
Miami, Florida

That considerable damage is caused by this insect in the Philippines is beyond question, though the principal mangos in cultivation appear to be fairly resistant to this pest. It is to some extent held in check by the numerous hogs which act as scavengers and devour the fallen fruit, and perhaps to an even greater extent by parasitic ichneumon flies. Hartless considers the mango fruit fly of minor importance in India,¹⁷ mainly attacking late varieties, while Burns¹⁸ estimates the damage from 15 to 30 per cent of the crop. It is also reported as very destructive to the mango in Assam.

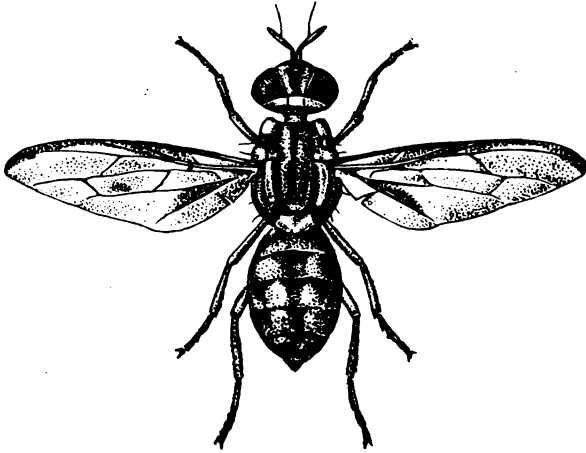


FIG. 8. A mango fruit fly, *Chaetodacus ferrugineus pedestris* Bezzi.
(Much enlarged)

The Mediterranean fruit fly, originally from tropical Africa, has spread to the Mediterranean countries, Brazil, Argentina, the Bermudas, Australia and Hawaii, and has been found exceedingly destructive to the mango.

The American fruit fly is distributed throughout the West Indies, Mexico, Central and South America, but has been reported as especially destructive to the mango in Porto Rico and Cuba.

The Queensland fruit fly is confined to Australia, possibly occurring in New Guinea, and has erroneously been credited to Java, India, and Ceylon. Together with the Mediterranean fruit fly it is one of the most serious mango pests in Queensland.

The Mexican fruit fly is confined to Mexico, where it is reported to be quite destructive.

Other fruit flies reported to attack the mango are *Ceratitis punctata* Wied., in tropical Africa, *Chaetodacus diversus* Coq.,

¹⁷ Agr. Jour. India, Vol. IX, Part II, 1914, p. 150.

¹⁸ Burns, W., Treatment of a Mango Plantation, 1911, p. 10.

in India and Ceylon, *C. melanotus*, Coq., in Cook Islands and *C. passiflorae* Frogg., in Fiji.

Aside from the mango fruit fly, 23 species and subspecies of fruit flies have been described from the Philippines. Altogether, 58 species and subspecies of fruit flies belonging to 5 genera have been described from India, Burma, Ceylon, Formosa, Java and the Philippines.¹⁹ The life history and habits of most of these species have never been studied but many undoubtedly attack the mango in addition to other fruits.

The fruit flies average about the size of an ordinary house fly and are variously colored depending upon the species. The eggs are deposited within the skin of the nearly mature fruits and the larvae rapidly tunnel into the fruit, which soon drops from the tree and decays.

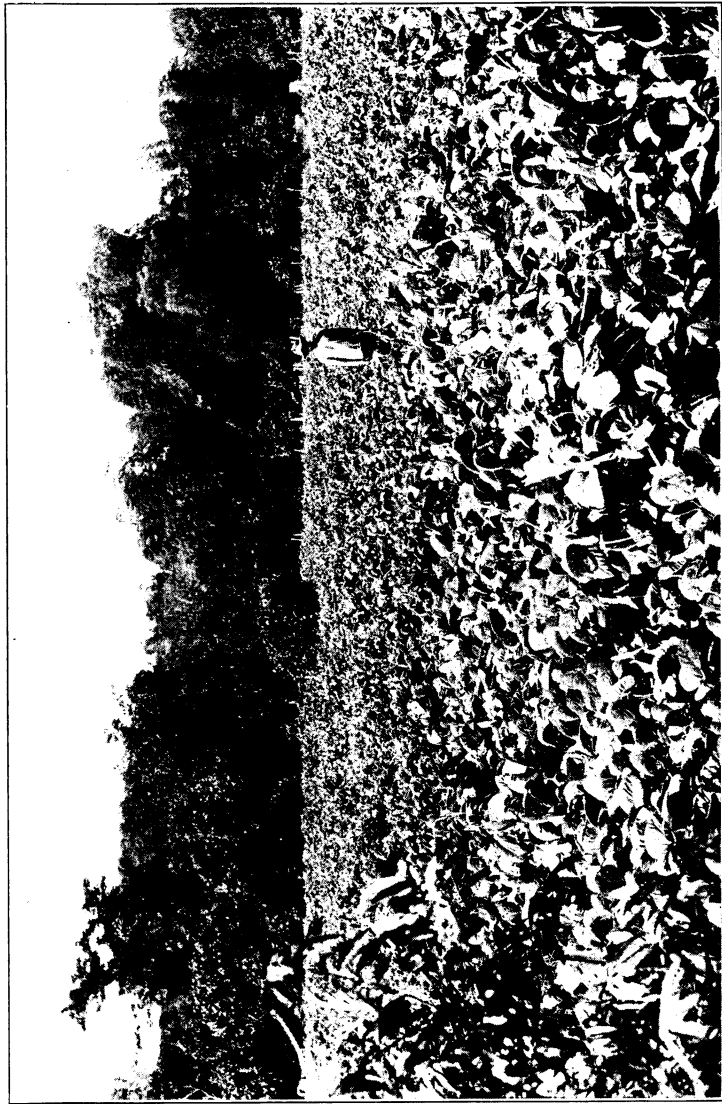
In the case of *Ceratitis capitata*, which may be considered fairly typical of the fruit flies and has been most thoroughly studied, the eggs hatch in from 2 to 6 days under tropical conditions, and remain in the larval stage for 9 to 20 days. When the larvae have attained their full development they leave the fruit and pupate in the ground emerging as fullgrown adults after about 10 to 20 days under tropical conditions. In Hawaii during the warmest weather the *Ceratitis capitata* has been found to complete the egg, larval and pupal stage in from 13 to 33 days, with 15 to 16 generations in a year. The length of the life of the adult has been found to vary from a few to over 300 days, with an average egg laying capacity of 150 to 400 eggs per female during her life, though some females have been recorded to lay up to 622 eggs.

Thus it is seen that where natural checks are absent the fruit flies are exceedingly destructive.

According to Back and Pemberton the mango is a favorite host of *Ceratitis capitata*. In Hawaii they counted 313 larvae in 12 fruits and in another instance obtained 423 fruit flies from 47 fruits. So badly has the mango been attacked by this pest in Hawaii that many owners are said to have been willing to have the crops removed and destroyed before infestation and ripening.

The fruit flies in the tropics become especially destructive and difficult of control because of the continued warm weather and the ripening of a large number of wild and cultivated fruits at all seasons of the year which enables the insects to breed without interruption. For the more destructive species attack the fruits

¹⁹ Phil. Journ. Sci., Vol. XV, 1919, p. 412.



A newly planted orchard with velvet beans as cover crop. Lamao Experiment Station

of many plants. The most thoroughly studied species, *Ceratitis capitata*, was in Hawaii found to attack 72 different plants.²⁰

A fruit infested with fruit fly maggots is unfit for human consumption. At the completion of the larval stage the maggots commonly leave the fruit and pupate in the ground.

Remedies.—In India, Porto Rico, Cuba, and Hawaii it has been noted that mango varieties differ greatly in their susceptibility to attack from the various fruit flies found in these countries, some varieties suffering greatly while others are highly resistant. It is obvious that other conditions being equal, preference in planting should be given to the fruit fly resistant varieties.

The fruit flies may be to some extent controlled by gathering and burning all drops and refuse fruits before the larvae leave and enter the ground to pupate.

Poisoned sugary sprays have been found effective in the control of fruit flies in South Africa, Italy and Australia, when systematically applied in combination with sanitary orchard management, but under Philippine conditions spraying would not be a practical remedy against this pest.

In the course of his experiments with the Mally fruit-fly remedy for *Ceratitis capitata* (Formula No. 8), Mally found that the percentage of infested fruit dropped from 50 per cent in unsprayed trees to 1 per cent in those treated.

Mally recommends that the first application be made a month before the presence of the larvae in the fruit is expected, and thereafter an application every ten to fourteen days is thought advisable. The aim should be to have the poisoned bait on the trees so long as the flies are present in the orchard. A comparatively small amount of the spray is applied to each tree, or about 1 to 1.5 liters to a tree of about 6 to 7.5 meters spread.

In applying the spray the nozzle should be directed so that the liquid shall fall in small drops over and through the trees²¹

In Hawaii the situation relative to the Mediterranean fruit fly has been somewhat ameliorated by the importation of several species of ichneumon flies parasitic on the fruit fly.

MANGO WEEVILS

There are two weevils, *Sternonchetus gravis* Fabr. and *S. mangiferae* Fabr., which attack the seed of the mango. The first mentioned species occurs only in India but the latter has spread until now it is found from South Africa through India and

²⁰ Back, E. A., and Pemberton, C. E., The Mediterranean Fruit Fly in Hawaii, U. S. D. A., Bul. No. 536, 1918, p. 24.

²¹ Agri. Journal Cape of Good Hope, 1909, Vol. 34, pp. 620-623; Vol. 35, pp. 578-581.

Malaysia, including the Philippines, to Hawaii. The egg is laid in the half or two-thirds grown fruit and the larva bores through the flesh without visible injury and enters the seed. The full-grown adult does not emerge from the seed until some time after the fruit has ripened. Apparently this is not a serious pest.

Remedies.—If it is true that the mango weevil breeds only on the mango, the restriction of this pest should be easy of accomplishment by destroying all drops and seed.

SCALE AND SUCKING INSECTS

Numerous scale insects have been reported attacking the mango in practically all countries in which it is grown. For convenience the scales are divided into two groups, (a) armored,²² and (b) unarmored.²³

The former are more or less protected by a waxy excrescence, while the latter are usually naked and thus more readily controlled by means of sprays.

²² The following armored scales have been recorded as affecting the mango.

Aspidiotus articulatus Morg.

—*clavigera* Ckl.

—*cocotiphagus* Mlt.

—*destructor* Sign.

—*hederae* Vull.

—*maskelli* Ckl.

—*mangiferae* Ckl.

—*longispina* Morg.

—*longissima* Ckl.

—*personatus* Comst.

—*trilobitiformis* Gr.

—*trilobitiformis daryuti* de Charm.

Aulacaspis cinnamomi New.

—*rosae* Bouché.

—*dilatata* Gr.

—*eugeniae* Mask.

—*natalensis* Ckl.

Chionaspis vitis Gr.

—*aonidium* L.

Chrysomphalus dictyospermi Morg.

Hemichionaspis aspidistrae Sign.

Leucaspis indica Mlt.

—*mangiferae* Mlt.

Parlatoria pseudaspidiotus New.

Pinnaspis buxi Bouché.

²³ The following unarmored scales have been recorded as affecting the mango.

Asterolecanium pustulans Ckl.

Ceroplastes ceriferus And.

—*floridensis* Comst.

—*rubens* Mask.

—*vinsonii* Sign.

Coccus acuminatus Sign.

—*acutissimum* Gr.

—*hesperidum* L.

—*longulus* Dgl.

—*mangiferae* Gr.

Geococcus radicum Gr.

Icerya minor Gr.

—*purchasi* Mask.

—*seychellarum* Wstw.

Llaveia axin Llave.

Monophlebus stebbingi mangiferae Gr.

—*octocondata* Gr.

Phenacoccus iceryoides Gr.

—*ballardi* Gr.

—*mangiferae* Gr.

Pulvinaria ficus Hemp.

—*mammeae* Mask.

Saissetia psidii Gr.

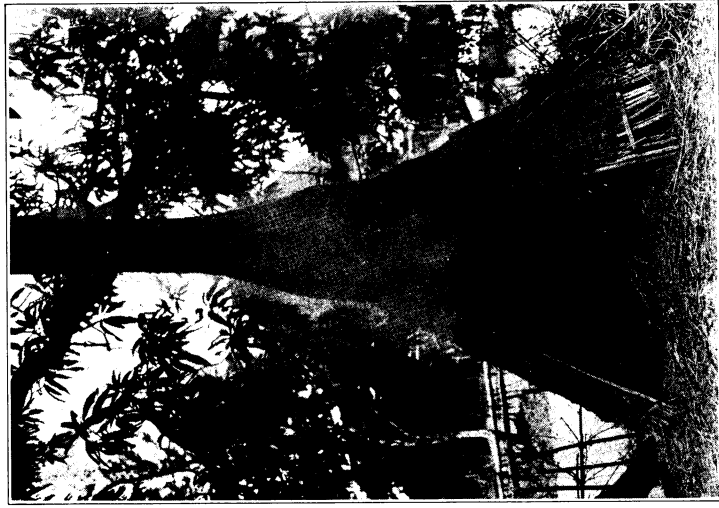
—*oleae* Bers.

—*punctilifera* Gr.

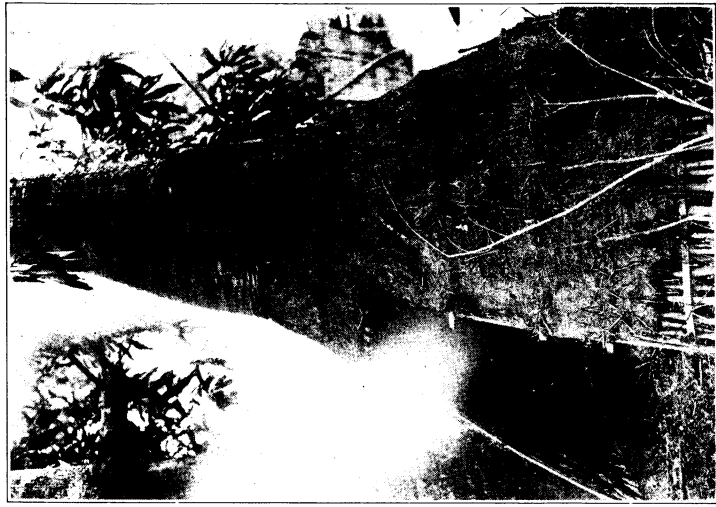
Tachardia lacca Kerr.

Trionymus americanus Ckl.

Vinsonia stellifera Wstw.



(a) "Fire-place" and smoke-stack used in forcing mango trees into fruiting, Cavite



(b) Near view of the "fire-place"

Many of these species are parasitic on other plants than the mango and several are found in the Tropics of both hemispheres; no species, however, so far as the writer is aware, has as yet appeared as a serious pest on the mango. This, however, affords no excuse to the importers of propagation material of the mango for relaxing their vigilance in regard to those insects, for no one can predict the future career of an insect in a new environment or in a climate which may be far more favorable for its multiplication than that in the country to which it is indigenous, and where usually an equilibrium of nature has been established which frequently prevents it from becoming a serious pest.

Of the *Physopoda*, two species of thrips, the greenhouse thrips, *Heliothrips haemorrhoidalis* Bouché, a small black insect, and the red-banded thrips, *H. rubrocincta* Giard., in its immature stage recognized by a red, transverse band across the abdomen, have been reported as injurious to the mango. The thrips are gregarious sucking insects that inhabit the under side of the leaf, when they are very numerous also attacking the young twigs. The injury is caused by their puncturing the tissues and sucking out the juice, with the effect that the trees drop their leaves if measures are not taken to destroy the insects. The thrips also attack the guava and many other plants.

The red spiders, *Tetranychus* spp., are minute, reddish, or reddish-purple, sucking insects, which sometimes attack the foliage of the mango during the dry season, but usually disappear with the approach of the rainy season.

Aleurocanthus woglumi is a small, black sucking insect, native of India, but which has been introduced into the West Indies and Central America where it is now causing considerable apprehension as a mango pest, and where it is known as *mosca prieta*.

Remedies.—The climate of the Philippines is very favorable for the development of parasitic fungi on the scale insects, which therefore have very little opportunity to get beyond control. If they should happen to do so spraying with formulas No. 2, 3, 4, or 5 would be found effective. The thrips, red spiders, and the "*mosca prieta*" yield to the same sprays.

MISCELLANEOUS INSECT PESTS

Hemipterous insects affecting the mango are more numerous than those from any other order. The mango hopper has already been discussed. The so-called "mango-fly," *Psylla cistellata* Buck., occurring in India, lays its eggs in the terminal buds of the mango, where the larvae feed on the tender tissues and de-

stroy them. The damage done by this insect in India does not appear to have assumed such dimensions as to call for direct measures for its control. The pruning and burning of all twigs affected should prove effective.

If this insect were introduced into the Philippines and if it were to find native plants congenial for its breeding habit, it might become a serious pest and its control prove a difficult problem.

There are two unidentified species of *Lepidoptera* in the Philippines the larvae of which do considerable harm to the mango: one enters the young, tender terminal growths and tunnels them, after which they wither and die; another larva, probably the same species, has in the flowering season been found to injure the mango flowers. Considerable damage to the mango flowers is also caused by a larva that feeds on the surface of the flower stems with the effect that they shrivel and die. These insects, as yet unidentified, are, together with *Idiocerus clypealis* Leth., *Idiocerus niveosparus* Leth., the twig borer, *Euclea capito*, and the fruit-fly (already referred to on a previous page), the principal, and as far as known at present, the only serious insect pests on the mango in the Philippines.

The larvae of the following *Lepidoptera* have been found to defoliate the mango trees in India; *Cricula trifenestrata* Helf., *Stauropus alternus* Walk., *Leucoma comma* Hutt., *Natada velutina* Koll., *Euproctis limbata* Butl., *E. lunata* Walk., and *Conthe-yea rotunda* Hmp.

Where it has appeared in large numbers, the last species mentioned is reported to have destroyed practically all the fruit as well as the foliage.

Remedy.—Hand picking and spraying with formulas Nos. 6 and 7.

Diaprepes abbreviatus L., in the West Indies, *Apoderus tranquebaricus* Fabr., in India, and *Diapromorpha melanopus* Lac., three beetles, feed on the foliage of the mango, but are probably of minor importance. They could easily be destroyed by an arsenical spray in case of need.

The mango bark borer, *Plocaederus ruficornis* Newm., in the Philippines sometimes tunnels in the bark of the large trees, and while a serious pest in isolated instances where it has gained entrance, in a broad sense it is of but little importance. According to W. Schultze the cuts made in the trunks of the trees to induce fruiting are favorite places with the females in which to deposit their eggs. *Gnoma luzonica* Erichs, is another

beetle the larva of which bores under the bark on the trunk and large branches. The most injurious borer in the Philippines is *Euclea capito* Pasc., the larva of which tunnels the twigs of the mango. Of late this borer has been found exceedingly destructive. Other similar borers are *Batocera titana* Thoms., in India, which bores into the sapwood, and *Epepeotes luscus* Fbr., in Java.

Remedy.—Where borers attack the branches, these should be pruned off and burned. Bark borers should be dug out of the bark and the wounds painted with coal tar.

SPRAYING

In order to be effective, the spraying should be thorough and the application liberal. The pressure should be sufficient to cause the spray to settle on the trees as a fine mist and not in large drops.

It is important that the spray mixture be well strained in order to prevent the nozzles from becoming clogged in the act of spraying. It is also well to remember that the *copper sulphate* and the *arsenates* are very poisonous and should not be left where they are accessible to children or domestic animals.

The arsenic sprays are employed in the destruction of biting insects that eat the leaves. Therefore, they should be sprayed on the foliage. As the insects eat the leaves they are then poisoned. The oily sprays or those containing sulphur are commonly referred to as contact sprays because they kill the insects by contact. Therefore, it is very important that these sprays be applied to the insects, for the spraying of the plants is ineffective.

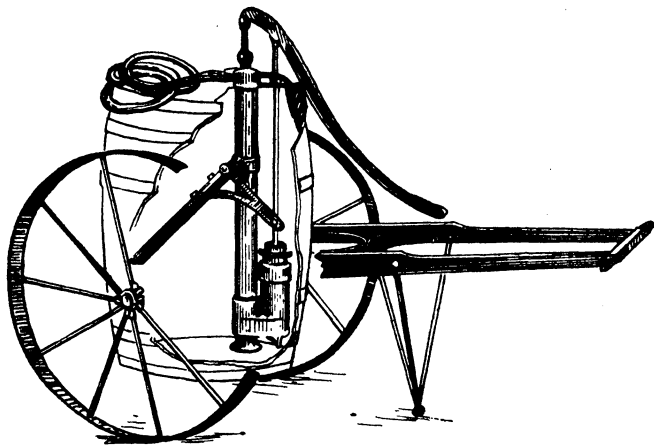


FIG. 9. Barrel sprayer

In the temperate regions, the self-boiled lime-and-sulphur wash, as a combined fungi- and insecticide, is now to a large extent displacing Bordeaux mixture and various contact sprays, and it is reasonable to believe that this spray is also valuable in the control of fungi and insect pests on the mango.

Among the sprays for biting insects on deciduous fruits arsenate of lead (formula No. 7) has taken the lead, and should prove equally effective in destroying similar insects on the mango.

For the owner of a few mango trees a "knapsack" or compressed-air sprayer that can be carried on the back by a man is large enough, but the small orchardist will find a barrel sprayer mounted on wheels, with 15 to 20 meters length of rubber hose attached, 13 millimeters in diameter, the most convenient. Large orchards require power sprayers mounted on a truck. The "Vermorel" is preferable to other types of nozzles.

FORMULAS FOR FUNGICIDES AND INSECTICIDES

1. BORDEAUX MIXTURE

FOR FUNGI

Copper sulphate	kilograms....	1.5
Unslaked lime	do.....	1
Water	liters....	100

Place the copper sulphate in a feed sack and suspend it in a barrel containing 50 liters of water so that the sack is just covered by the water. Slake the lime in another vessel and when slaked dilute to 50 liters. Before mixing stir the two solutions vigorously. Then dip a bucket from each solution and pour the two liquids together in the spray barrel, at the same time agitating the mixture vigorously. An excess of copper sulphate is injurious to the foliage, and before spraying the mixture should therefore be tested. This is done by inserting and holding in the mixture a clean steel blade for one or two minutes. If copper is deposited on the blade, more lime must be added. Use the mixture at once.

2. GOOD'S CAUSTIC POTASH WHALE-OIL SOAP

FOR SCALE AND SUCKING INSECTS

Whale oil soap	kilograms....	3-6
Water	liters....	100

3. KEROSENE EMULSION

FOR SCALE AND SUCKING INSECTS

Kerosene	liters....	7.5
Hard soap	kilogram....	.25
Water	liters....	4

Dissolve the soap in boiling water and while still very hot add the kerosene. Churn the liquid steadily for fifteen or twenty minutes by using a force pump, the liquid being pumped back into the vessel until it is emulsified. Sufficient hot water should be added to make the solution 16 liters in volume. For spraying dilute at the rate of 1 liter of the emulsion to 15 liters of water.

4. RESIN WASH

FOR SCALE AND SUCKING INSECTS

Resin	kilograms....	9
Caustic soda (98 percent)	do.....	2.25
Fish oil.....	liters....	1.5
Water	do.....	75

Pour 75 liters of water over the resin (which should be well broken up) caustic soda and fish oil in a large iron kettle, and boil for three hours. Then add hot water from another boiler (which should be provided for this purpose) from time to time and stir thoroughly until there are 190 liters of the solution. If desired for immediate use, dilute each liter of the solution with 2 liters of cold water before using. If kept as a stock solution, it should be diluted at the same ratio when used.

5. SELF-BOILED LIME-SULPHUR WASH

FOR FUNGI AND SCALE

Quicklime	kilograms....	3
Sulphur (flour or flowers)	do.....	3
Water	liters.....	100

Place the lime in a barrel and pour on enough water to cover it. When the lime begins to slake, add the sulphur after running it through a sieve to break the lumps. Stir the mixture constantly and add water as needed to form a thick paste at first, and then gradually a thin paste. The lime will supply enough heat to boil the mixture several minutes. As soon as the lime is well slaked add water to cool the mixture and prevent further cooking. Strain carefully, working the sulphur through the strainer, and dilute to 100 liters.

If it is desired to make the spray efficient against biting insects, Paris green, London purple, or arsenate of lead may be added to the lime-sulphur wash at the same rate as recommended in formulas Nos. 6 and 7.

6. PARIS GREEN

FOR BITING INSECTS

Paris green.....	grams....	60-120
Quicklime	kilograms....	0.5-1
Water	liters....	100

Place the lime in a wooden vessel and slake, dilute to 100 liters and add Paris green. London purple may be substituted for Paris green and used at the same rate. Both these poisons, particularly the Paris green, have a tendency to settle and the liquid should be kept in constant agitation during the spraying, else the spray from the bottom of the barrel may seriously damage the foliage while the rest of the spray is useless.

Paris green, London purple, or arsenate of lead may be used in combination with Bordeaux mixture. They are then added as if the Bordeaux mixture was water.

7. ARSENATE OF LEAD

FOR BITING INSECTS

Arsenate of lead.....	kilograms....	0.5-1
Sugar	do.....	0.5-1
Water	liters....	100

Slake the lime in a wooden vessel, dilute to 100 liters and dissolve the arsenate of lead in the liquid.

8. THE MALLY FRUIT-FLY REMEDY

Arsenate of lead.....	kilograms....	0.6
Sugar	do.....	7.5
Water	liters....	100

Dissolve the arsenate of lead in a small quantity of water, dilute to 100 gallons and add sugar.



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